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History

Tracing the Origins of the W76: 1966–Spring 1973 (U)

Betty L. Perkins

November 3, 2003

Redacted Version

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TRACING THE ORIGINS OF THE W76: 1966–SPRING 1973

by

Betty L. Perkins

ABSTRACT (SRD)

The objective in writing this report was to place the development of the W76, before it entered Phase 3, in a historical perspective. The author has rather arbitrarily chosen to consider for this pre-Phase 3 history, the history of the weapon program at Los Alamos during the years 1966–May 1973.

The report tries to provide some understanding as to why, in the spring of 1973, the Los Alamos Scientific Laboratory received the Phase 3 assignment and why the assignment was important to the future of Los Alamos. In addition, the report provides insight into why historically the design of the W76 evolved as it did.

Chapter I provides general information including the organization of the Laboratory during the time-period of interest and the definition of what is included in the different phases in weapon development.

Chapter II discusses the work on primary design.

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Chapter IV briefly describes the early development effort for several of the materials that would be important in the W76 program

(b)(3) The engineering status of several ancillary components such as detonators and gas storage systems is reported. Chapter IV notes the vulnerability tests relevant to the early LASL XW76 weapon program.

Chapter V includes a brief discussion of the history of the weapon systems assigned to Los Alamos as Phase 3 programs during the 1966–spring 1973 period. The extensive effort that was required for the various Phase 1 and 2 programs and the early advanced development programs under consideration during these years is also discussed. It is noted that despite this effort, the Los Alamos weapon teams failed during 1966–1972 to win a viable Phase 3 assignment to develop a warhead for a strategic missile weapon system. The chapter also includes some trends in the U.S. nuclear stockpile that are important in understanding the 1970–1980s weapon programs.

Chapter VI outlines the Los Alamos effort for the Mk 18 and the later Mk 400 programs; programs that served as the precursor programs to the W76. This chapter provides insight on the Los Alamos effort to obtain a Phase 3 assignment for a strategic warhead and the success in this effort that resulted in the long desired award of the XW76 program to Los Alamos.

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CHAPTER I. INTRODUCTION

A. Explanation

1. Assignment

The assignment given to the author was to outline the history of the development of the W76 warhead (presently carried on both the Navy's Trident C4 and D5 submarine-launched ballistic missiles). Because the Los Alamos Scientific Laboratory [LASL] received the Phase 3 assignment for this warhead in the spring of 1973, it would be reasonable to assume that a history of the W76 would cover only the period from the Phase 3 assignment until the initial operational capability of the W76 was achieved in October 1979 (Poseidon back-fit). But history is continuous. What happens at one point in time is dependent upon what happened earlier.

In order to set the development of the W76 in the necessary perspective, give some understanding as to why in the spring of 1973 LASL received the Phase 3 assignment and why the assignment was important to the future of Los Alamos, and indicate several reasons why the design of this device evolved as it did, a history of work prior to 1973 is required. The author has rather arbitrarily chosen to consider for this history, the history of the weapons program at Los Alamos during the years 1966–May 1973. (However, to give continuity, some aspects of the program are also described for work completed before 1966.) This pre-Phase 3 effort at Los Alamos is the focus of this report.

However, the author must insert a warning to the reader. It must be noted that to further increase the complexity that is history, it is almost impossible to identify all the factors that go into determining actions during a specific era. In addition, the description of an event is dependent upon the available "data set" of historical documents. Moreover, how an event is described in a point in time is dependent on what happens later and on our own personal experiences, knowledge, and "mindset." Thus, no history can be completely objective.

2. Overview

Before the award of the design effort for the W76 to Los Alamos, the U.S. nuclear weapon designers had been required—by the introduction of MIRVed (Multiple Independently Targeted Reentry Vehicle) missiles into the U.S. weapon arsenal—to develop lightweight/small warheads for use in the missiles' reentry vehicles.

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Chapter IV will briefly describe the early development effort for several of the materials that would be important in the W76 program.

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The engineering status of several ancillary components such as detonators and gas supply systems will be reported. Chapter IV will also note the vulnerability tests relevant to the LASL XW76 weapon program.

Chapter V will outline and briefly discuss the history of the weapon systems assigned to Los Alamos as Phase 3 programs during the 1966–1972 period. In addition, mention will be made of Phase 1 and 2 programs and early development programs under consideration during those years. This chapter will attempt to inform the reader as to the extensive effort that was required. However, as Chapter V will also describe, the Los Alamos weapon teams failed during 1966-1972 to win a viable Phase 3 assignment to develop a warhead for a strategic missile weapon system. The W62 for the Minuteman III with a Phase 3 of 1964 went to Livermore. The W68 for the Navy's Poseidon submarine with a Phase 3 of 1966 also went to Livermore. Earlier, the W56 (the warhead for the Minuteman I, II) and the W58 (the warhead for the Navy's Polaris) had also gone to Livermore. The Chapter will also note some trends in the U.S. nuclear stockpile that were important for the weapon programs at the Livermore, Sandia, and Los Alamos laboratories.

Although the program was finally canceled, of particular importance to the later W76 development was the Mk 18 program. This program will be covered in some detail in Chapter VI. The Navy's Mk 400 program was the precursor program to the W76. The history of *the Mk 400 program will also be outlined in Chapter VI. This chapter will discuss the vital* question: who would win the Phase 3 for the Mk 400 (XW76) Los Alamos or Livermore?

B. Los Alamos Scientific Laboratory Management Structure and Philosophy

1. Norris Bradbury

Norris Bradbury served as the director of the Laboratory at Los Alamos from October 1945 until September 1970. When he accepted this job and became director in October 1945 just after the end of WWII, he promised that he would serve for six months. But the six months of service stretched into twenty-five years.

In a January 1967 letter to Charles Winter, Deputy Director of the Division of Military Application, Bradbury described the Laboratory, "Los Alamos is organized on a facility and technology basis; LRL is organized more on a project basis." Bradbury also noted, "Internally in the Laboratory, the weapon program is steered by a committee chaired by the Laboratory Director and comprised of Assistant Directors and relevant Division Leaders. Basic decisions are made by this group, the members of which carry the authority within their respective areas of responsibility to implement them. More detailed discussions and decisions within the framework

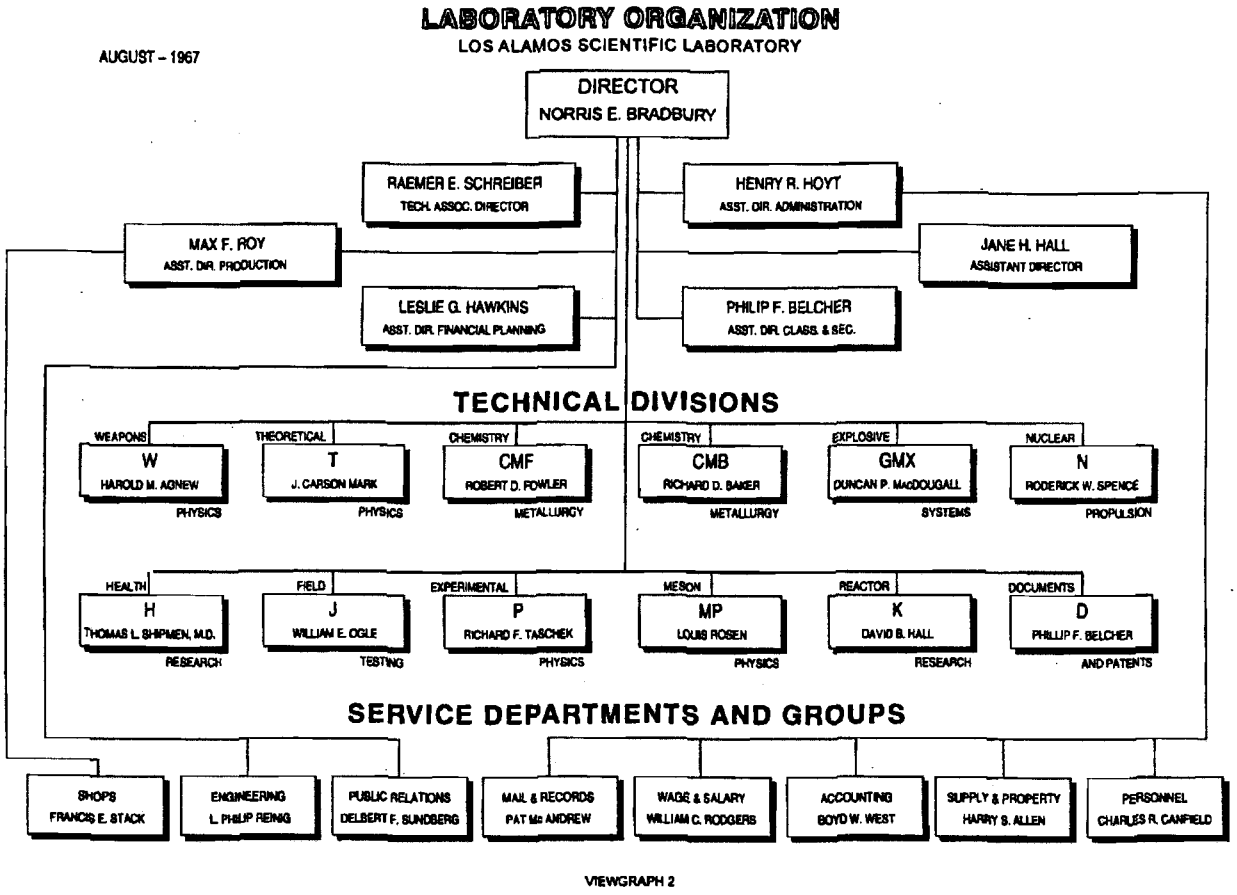

Figure I-1. Laboratory Organization August 1967
Source: "Summary, SAC Briefing, August 15, 1969," W-9-481 (U) (August 25, 1969), p. 8, A99-019, 215-17.

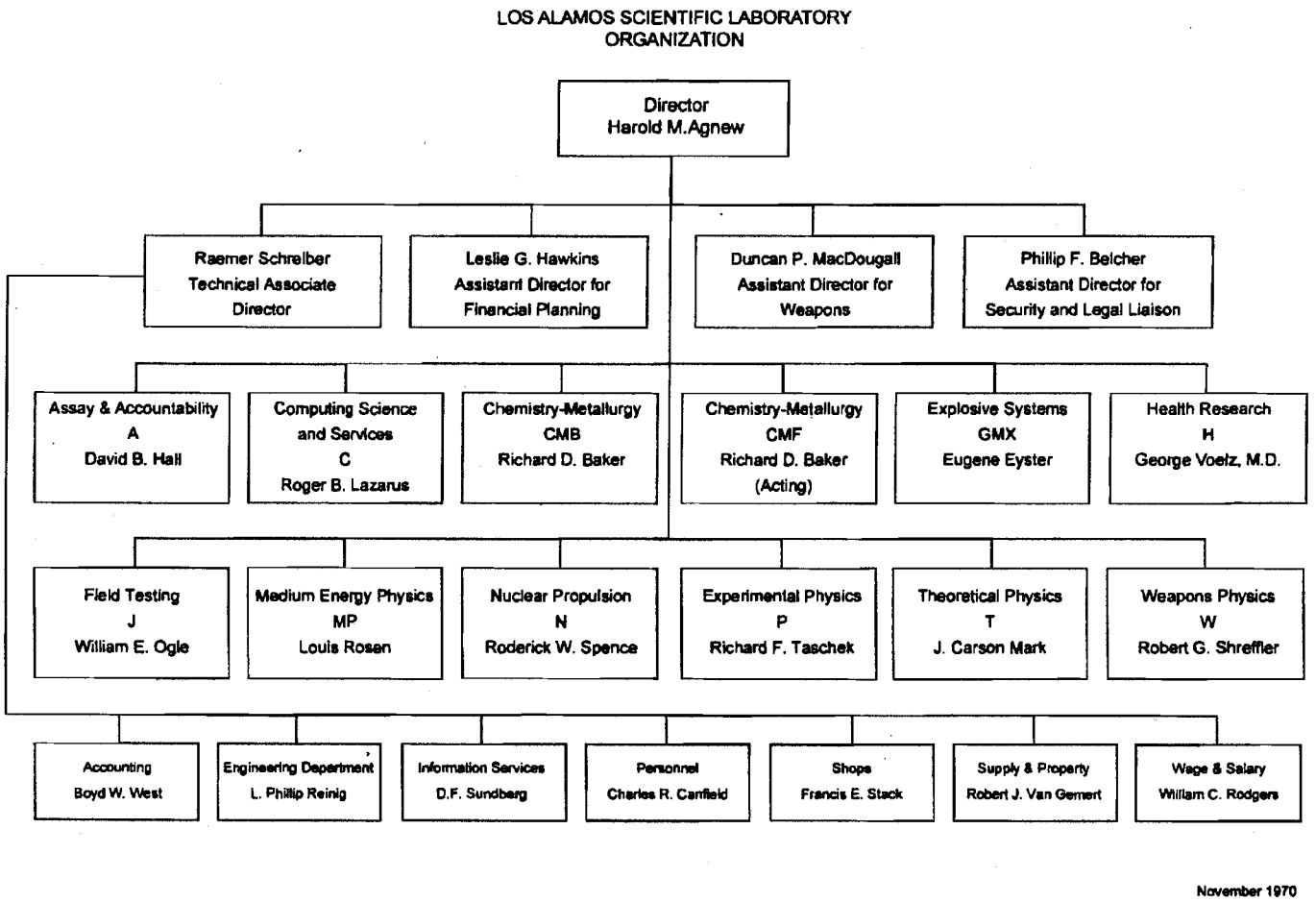

Figure I-2. Laboratory Organization November 1970
Source: "Los Alamos Scientific Laboratory Organization," (U) (November 1970), 1 p., A88-011, 2-30.

made by the Defense Department. It we weren't providing the technology that allows these high yields in smaller packages to be made we wouldn't be keeping up with the Soviets because the number of Minuteman we have is the same and the number of submarines is the same. It is the warhead technology that enables this country to keep up its deterrent, and that is only because of the technological base which the weapons laboratories supported by the Committee and the Commission provide the country."[4]

As part of his new job as director at Los Alamos, Agnew would continue and intensify his campaign for Los Alamos to receive the Phase 3 assignment for the W76. He was successful in this effort.

C. Weapon Group Designations/Responsibilities, Support and Basic Research Groups, and Committee Functions

As noted in the organization charts of Figures I-1 and I-2, the work at Los Alamos took place along the lines of various disciplines. A set of Divisions, each concerned with a particular interest was set up. In each Division there were groups where the work was again more narrowly specified. However, to produce a specific weapon, members from all the different divisions came together as needed. The following sections will attempt to explain how the Laboratory functioned in terms of organization.

1. Weapon Groups: 1966–September 1972

a. Weapon Design

Very early in the history of the various groups in the Laboratory (1948–December 1970), W-4 was designated as the small weapons theoretical design group responsible for the design of single-stage devices and primaries. However, in January 1971, a division known as TD-Division, responsible for the theoretical design of nuclear weapons, was created. Group members in W-4 then became group members in what was designated TD-4.

Until the formation of TD- and C-Divisions, members of T-Division were responsible for computing, code development, theoretical problems in mathematics, and some aspects of weapon design. For a number of years, until 1973, Carson Mark was the Division Leader. Another important member of the division office at that time was secondary designer Robert Thorn. Until Thorn became TD division leader in 1971, he also headed T-2. (A "new" T-2 group called the Nuclear Data group was then formed in April 1971.) Formed in September 1959, T-3 was the hydrodynamics group. Until it became TD-1 in January 1971, T-4 (which had become a group in May 1970) was also a weapons group in T-Division. (Beginning in October 1971, the "new" T-4 became the group concerned with equation of state and opacity.) The group T-5 members were concerned with numerical analysis; in January 1971, this group became TD-5. From July 1963 until January 1971, T-6 was the fission weapons design group. [Author's note: This group under Dave Woods was apparently a backup design group for the other design groups. By having multigroups, it was possible to see if the design teams agreed.] Group T-7 was the computer research and development group. In April 1968, its members joined C-Division. Members of T-8 were concerned with applied mathematics (mathematical methods). Their well-known group

[4]"Remarks by H. M. Agnew Concerning Need for Testing," (June 15, 1970 Briefing), DIR-2244 (SRD) (October 9, 1970), pp. 7.6–7.7, A99-019, 269-1.

leader was Stanislaw Ulam. In the January 1971 reorganization, members of this group were split into TD-5 and TD-6. The weapon effects group was T-12—until the group was dissolved in July 1968. Once TD-Division and C-Division were formed, the interests of members of T-Division were those required to provide theoretical and analytical support to most of the major programs of the Laboratory.

C-Division was formed in April 1968 from parts of T-Division and Data Processing. This division was called the Computing Sciences and Services Division. Thus the name indicated the type of work for which the division member's were responsible. Nicholas Metropolis served as an advisor from April 1968 to March 1974. In 1972, the members of C-Division were responsible for maintaining and operating one IBM 7094, two CDC 7600s, three CDC 6600s, two IBM 1401s, and one IBM 1360. In addition, the members' interests included research in statistical theory and development of methodology, consultation, assistance in numerical procedures and techniques for problem solving, numerical analysis, and applied mathematics and programming.

On January 1, 1971, a new division was formed that included the "old" T-2, T-4, T-5, T-8, and W-4 groups. This division was called TD, or the Division of Theoretical Design. Members of the division office included several members of the Los Alamos weapon design team. Robert Thorn was the division leader with Harry Hoyt the alternate division leader. TD-1 was called the Thermonuclear Weapons Physics group. TD-2 was the Thermonuclear Weapons Design group. It was this group that was chiefly concerned with the design of secondaries. TD-3 was Weapons Outputs. Another very important group was TD-4, Small Weapons Design. This group was responsible for the design of single-stage weapons and the primary in multistage weapons. TD-5 was called Codes Development. TD-6 was the Monte Carlo group. Concerning TD activities as of June 1972, it has been reported, "This Division is responsible for the theoretical design of nuclear weapons. The Division is responsible for work on the physical principles of nuclear weaponry, research and development on new concepts, and output effectiveness studies of various classes of weapons. An important portion of the effort is directed toward design and interpretation of nuclear weapon tests. ...The personnel of the Division perform calculations based on fundamental theory but use as a database experimental data from other groups of the Laboratory."

Most of the work in T, C, and TD took place in the main technical area, called TA-3.

b. HE Production and Development and In-House Field Tests

A division called GMX was formed in 1948. This division, divided into a large number of groups, was responsible for explosives and "their interaction with metal." Duncan MacDougall was division leader from August 1948 until September 1970 when MacDougall became Assistant Director for Weapons. [Author's note: It should also be noted that another strong figure in the early weapon program was Max F. Roy. He served in the director's office as Assistant Director for Production from August 1948 until his retirement in June 1970. There is a story that circulates in the laboratory that Max Roy wanted to contract work out, but MacDougall wanted the work done in-house.] Eugene H. Eyster served as alternate GMX division leader between 1954 and 1970 when at that time he became division leader.

GMX-1 was the nondestructive testing group. As will be noted, this group became, in September 1972, M-1. Their main work site was TA-8 (Technical Area 8). This site is known as

GT site in honor of Gerold Tenney. X-ray techniques were important in the diagnostics conducted by this group. The group also had test facilities at TA-40, also known as DF Site.

Group GMX-2 was the explosives research and development group. It would become WX-2. Included in the GMX-2 work was the development of new types of explosives. Nemo development was also successfully accomplished. The group members worked at the site known as TA-9 or Anchor Ranch. The group also had test facilities at TA-14, also called Q Site.

GMX-3 was the large high-explosives and implosion-systems group that would become WX-3. This was an important group that was responsible for much of the work relevant to high explosives. The large site known as S-Site, TA-16, was the site at which work on explosive manufacture, machining, and testing took place. There was also an HE burning ground. (TA-16 included several sites that had previously, during the Project Y period, had specific names.) The group also had test facilities (including a drop tower) at TA-11, or K-Site.

GMX-4 was the pin techniques group and as such its members were responsible for the pin shots conducted at TA-15 (also known as R Site). Eric L. Peterson was group leader from 1948 until 1971. This group would become M-4.

GMX-11 was the Phermex group. As the group name implies, the members of this group used the Phermex facility to provide important diagnostics on weapon behavior. They too used the TA-15 site. Douglas Venable was group leader from November 1963 until September 1972. Under reorganization in September 1972, the group become M-2.

GMX-6 was the group concerned with optical techniques. It would be this group that would in general, as part of the weapons program, do case diagnostic and related shots. Their test facilities were at TA-39, known as Ancho Canyon Site.

GMX-7 was the group responsible for detonators, firing, and cables. This group would become WX-7. The main area for operation of this group was TA-22, known as TD (Trap Door) Site. Test facilities were also located at TA-40, DF Site.

GMX-8 was the explosives phenomena group. In the 1972 reorganization, this group became M-3. Their test area was at TA-36, known as Kappa Site. The specific areas at this site had names such as Eenie, Meenie, Minie, and Lower Slobbovia.

GMX-9 was the photography group, known as the fast cameras in optics. Their group leader was Berlyn Brixner. Their laboratories were at TA-8.

GMX-10 was called the statistical mechanism and detonation theory group. This group was dissolved as part of the 1971 reorganization.

The GMX field-test groups, and later the equivalent M field-test groups, gave their field-test shots numbers. Thus, as will be noted in the following chapters, each shot record is identified by a specific shot number.

c. NTS Test

The division responsible for the preparation and completion of tests at NTS, including certain diagnostics, was J-Division. This work included ensuring that all the tests were conducted safely and, for the underground tests, the use of proper stemming techniques to ensure containment. The division members also were responsible for the construction and maintenance of field-test facilities. Thus, the work included mechanical design engineering, structural analysis, vacuum technology, and underground phenomenology. Several members were concerned with nuclear weapon effects. William Ogle was division leader from 1965 until October 1972 at which time Charles I. Browne became division leader.

J-1 was concerned with personnel and administration. Group J-3 was responsible for plans, operations, and administration, NTS. Beginning in 1965 the group was located in Nevada under the leadership of Robert Beiler (who left the group in 1979). J-6 had the responsibility of engineering and construction, or facility production. Equipment, engineering and specifications, including downhole design were the responsibility of J-7. J-8 was the electrical engineering group, and their responsibilities included overseeing the timing and firing of the test device.

From March 1971 until September 1979, the group J-9 was known as the underground test phenomenology group. The diagnostics based on radiochemistry were performed by members of J-11 from 1951 until January 1971 when the nomenclature of this group became CNC-11 (Nuclear Chemistry). The laboratories and analytical equipment required for the J-11 radiochemistry program were located at TA-48. (Calibration of equipment and similar activities were conducted at the reactor at TA-2.) Group J-12 was responsible for neutron measurements. In July 1971, the name of the group was changed to Neutron Measurements—PINEX. During the same time period, members of Group J-14 were responsible for the reaction history diagnostics. (During 1966, J-14 had been formed from personnel from J-10.) As part of their responsibilities, J-15 members were responsible for hydrodynamic yield. In general, members of the J-Division groups were greatly assisted by organizations such as EG&G and REECO that were contractors to the Laboratory.

In 1972, the division was known as J-Division Field Testing. The various weapon-related groups in this division as reported in November 1972 are noted below:

Group	Name
J-1	Operations
J-3	Operations NTS
J-6	Facility Production
J-7	Downhole Design
J-8	Timing and Firing—Phenomenology Support
J-9	Underground Test Phenomenology
J-12	Neutron Measurements—Pinex
J-14	Reaction History
J-15	Diagnostic Design Hydrodynamics

d. Engineering and Design

W-Division was the designation of the nuclear weapons engineering division. The division members accomplished Phase 3 development for all non-HE components, built prototypes for NTS shots and performed tests to see how a weapon might behave. In addition, W-Division was the principal point of contact within the laboratory for all nuclear weapons programs. As previously noted, Harold Agnew was the division leader from August 1964 until he became director in the fall of 1970. He was then replaced with Robert G. Shreffler. The division was dissolved in September 1972 when most groups joined WX-Division.

The W-1 group was known as weapons engineering. In September 1972, it became WX-1. For many years, Jacob J. Wechsler headed this group. The group was located in the canyon at

TA-41. Group W-7 was the group concerned with the physical and chemical properties of weapon materials. They too were located in Los Alamos canyon at TA-41. This site had a tunnel in the hillside used for secure storage. The tunnel was known as the Ice House, a carryover from Project-Y days when the storage facility was a former ice house. The group had a varied assignment program that covered such diverse activities as responding to accidents involving nuclear weapons to the study of pit hydriding. This group became WX-5.

W-3 was the group concerned with gun-device engineering. The work of this group will be noted in Chapter V in the discussion of the LASL gun-type weapon programs. This group was located at TA-33.

Group W-8, before it was dissolved in February 1972 and absorbed by P-3, was the group responsible for vulnerability and neutron physics. Group W-10, which became a group in 1970, was designated X-Ray Effects on Weapons. It became WX-6.

As will be noted in Chapter V, W-9 was formed in 1968 to provide an interface between the Laboratory and the Military. This group was called the Department of Defense Liaison group. In effect, the group members had the responsibility of "explaining" laboratory programs to the Military and responding to the large number of requests, such as input for the Phase 2 reports, from the DOD and related departments.

e. Materials

In 1972, CMB-Division personnel were responsible for both basic and applied research and development in the fields of chemistry, metallurgy, and chemical engineering.

f. Radiochemistry

In 1971, the former J-11 group was moved into the CNC-Division. The members of CNC, as well as providing the radchem test yields, were interested in low-temperature physics, the study of transuranium elements, and radioactive half-lives.

2. Weapon Groups: Reorganization and September 1, 1972, Designations

The following changes were made when the two new divisions WX and M were formed on September 1, 1972:[5]

WX-Division		M-Division	
New Designation	**Old Designation**	**New Designation**	**Old Designation**
WX-1	W-1	M-1	GMX-1
WX-2	GMX-2	M-2	GMX-11
WX-3	GMX-3	M-3	GMX-8
WX-4	W-3	M-4	GMX-4
WX-5	W-7	M-5	GMX-9
WX-6	W-10	M-6	GMX-6
WX-7	GMX-7		

[5]"Minutes of the 177th X-Unit Steering Committee Meeting (U), September 21, 1972," WX-7-72-4 (SRD) (October 13, 1972), pp. 2–3, B11, Drawer 53, Folder 1 of 2.

E. H. Eyster was appointed WX-Division Leader with B. L. Moore, M. L. Brooks, and R. W. Drake in the Division Office. For M-Division, W. E. Deal was appointed Division Leader, with Douglas Venable, W. W. Wood, J. J. Erpenbeck, and F. R. Parker in the Division Office.[6]

M-Division was known as the Dynamic Testing Division. Thus, the members of this large division were responsible for all the on-site field tests so necessary in the weapon program. The new M-1 group was known as Nondestructive Testing, and its members continued to be at TA-8. M-2 was the Phermex group. Members of this group were, of course, located at TA-15. M-3 was Detonation Physics (located at Kappa Site). M-4 was Pin Diagnostics and Neutron (located at R Site). M-5 was Optical Engineering and Repair. M-6 was Shock Wave Physics (located at Ancho Canyon).

After it was formed, WX-Division was originally designated the Weapons Engineering Division. The division office included a staff responsible for the overall management of such areas as engineering, plans and budgets, operations, hydrodynamics, testing, weapons systems, advanced development, new technologies, and reimbursable programs. WX-1 was given the name Nuclear Components and Engineering. Again, Wechsler headed this important group at TA-41. WX-2 (TA-9) under Louis C. Smith was called Explosive and Other Materials Development. Staff members would, as pointed out in Chapter IV, play a critical role in the development of new materials for the XW76. With the group headed by Jesse Aragon, Group WX-3 members were concerned with high-explosive implosion systems development. The group continued to operate the facilities at TA-16 and TA-11. The gun group, WX-4 (TA-33) was absorbed into WX-5 in April 1973. A new WX-4 group formed in December 1975 was responsible for design systems. It had formerly been ENG-6.

The material development group formerly W-7 was renamed WX-5. The group continued to work at TA-41. W-10 became WX-6, and the group members continued to be concerned with vulnerability and lethality. Although GMX-7 was renamed WX-7, the group members continued to be concerned with detonators and detonating systems at TA-22. Their work on the XW76 will also be noted in Chapter IV.[7]

3. Support and Basic Research

Not included in this list are the various required support groups. These included groups whose members were involved in personnel, payroll, procurement, engineering, component fabrication, health and safety, the technical library, and similarly important functions.

Moreover, there has always been the philosophy at Los Alamos that to have a viable weapons program the laboratory also had to be a first-rate scientific research facility. Thus, there were several groups whose members were interested in basic research in mathematics, physics, biology, materials, and similar scientific disciplines. There was also a great deal of interest in the development of new diagnostic tools, including accelerators.

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[6]"Minutes of the 177th X-Unit Steering Committee Meeting (U), September 21, 1972," WX-7-72-4 (SRD) (October 13, 1972), pp. 2–3, B11, Drawer 53, Folder 1 of 2.

[7]Alison Kerr et al., two-volume informal history of the organizational structure of the Los Alamos Laboratory, (U) (no date), located in the Los Alamos archives. Applicable Los Alamos phone books (U). "Nuclear Technology and Analysis Report (U)," Field Command Defense Nuclear Agency, Kirtland Air Force Base, New Mexico 87115 report FC/06720008 (SRD) (June 1, 1972), pp. 56–61, B11, Drawer 57, Folder 1 of 1.

Beginning with the Niblick operation, testing went on more or less continuously. However, the same program of deciding on a test list and the use of an operation name was continued. The named operation extended from one fiscal year (FY) to the next. Thus, the Storax operation extended through June 1963. Niblick operation tests continued from July 1963 through June 1964. Whetstone tests continued from July 1964 through June 1965. Whetstone was followed by Flintlock that took place from July 1965 until June 1966. Flintlock was followed by Latchkey, FY1966–FY1967; followed by Crosstie, FY1967–FY1968; followed by Bowline, FY1968–FY1969; followed by Mandrell, FY1969–FY1970; followed by Emery, FY1970–FY1971; followed by Grommet, FY1971–FY1972; and this operation was in turn followed by Toggle, FY1972–FY1973. The reader will notice these names throughout the remaining chapters.

The name of each operation was chosen in Washington.[8] DMA [Division of Military Application] staff member Ken Adney recalls that while he was at DMA in the 1960s–1970s, he and staff member Irv Williams would propose names for the operation. They tried to think of names that might be related to the particular service of the Military that the person in charge belonged to. Once the list was presented to the person in charge, [such as the Director of Military Application or later the Assistant General Manager for Military Application] this person then selected the operation name from the list.[9] The Whetstone through Toggle series appear from their names to represent small, but important, items that were used, or had been used by those in the service. The name Niblick was perhaps a reminder that someone liked to play golf.

2. Event

With as many tests as the U.S. conducted, it was a nontrivial task to specify a suitable event name for every test.

After the early test program, a formal procedure for naming names was initiated. In order to make the task more organized, the decision was made to designate a family class of nouns. The family type (along with names representing this family) was submitted to the Atomic Energy Commission (AEC). The AEC in turn would announce which names had been approved. These families of names included San Francisco streets, types of cheeses, games, nautical terms, plants, animals, Indian tribes, and tools.[10]

Perhaps one of the best sources of names for the Los Alamos group was to make use of the place names in New Mexico. In 1965, the University of New Mexico press published a small book called *New Mexico Place Names, a Geographical Dictionary*, edited by T. M. Pearce, assisted by Ina Sizer Cassidy and Helen S. Pearce. Most place names found in New Mexico are listed in this publication, and a short paragraph explains where the named location is and how the name originated. This dictionary contains more than 5,000 individual items. With such a dictionary in hand, the Los Alamos weapon groups found it easy to obtain shot names.

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[8]John C. Hopkins, personal communication (U) (January 15, 2003).
[9]Patricia Nolin Bodin through John C. Hopkins, personal communication (U) (February 11, 2003).
[10]John C. Hopkins, personal communication (U) (June 7, 2002).

CHAPTER II
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The basic idea came from Famularo, Juveland, and Cremer; Bernard and Jacoby contributed to the development of the principle in HE-driven systems. It started with a study of gun devices in an attempt to make them lighter and to drive them with lower reactivities." Additional historical information is available in the cited reference.[14]

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[14]Beverly A. Wellnitz, "Weapons Working Group, Minutes of the 215th Meeting," WWG-215 (SRD) (October 29, 1969), pp. 5–6. A99-019. 92-19.

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a. Military Requirements for Small, Lightweight Warheads

As noted previously, in the mid-1960s the Los Alamos design group had begun work on 10-inch diameter or less primaries,

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The reason for this great interest on the part of the design laboratories in the 10-inch and less diameter was the fact that the Military was pushing for small, lightweight systems. By this period, the missile/guidance/nose-cone establishment in the United States had developed their systems to where it appeared that it would be possible to put several warheads on one intercontinental ballistic missile (ICBM), deploy the missile, and have each of the warheads hit a different target. This concept is referred to as use of multiple independent reentry vehicles (MIRV). It was felt at that time that the USSR was also going into these types of systems. Because a warhead is much less costly than a missile, the Military wanted to pack as many warheads as possible into each missile. This desire for as many warheads as possible on one missile pushed the nuclear weapon groups to achieve as small as possible in terms of diameter. Moreover, the Military wanted as long a range as possible for each missile; this requirement pushed the weapon groups to try and design minimum-weight warheads.

A request for multiple-carriage capability for the forthcoming improved Minuteman system was formalized in a January 1963 revision to the Phase 1 study. Three reentry vehicles were to be carried in this system—designated the Mk 12 (L). On February 12, 1964, Phase 3 authorization was given for the Mk 12 (L). Livermore and Sandia Corporation, Livermore, were to receive the assignment (the warhead would carry the designation XW62). In November 1964, the Military Characteristics were amended to provide a warhead "compatible with a MIRV application on the advanced Minuteman missile system."[95]

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On August 31, 1964, in a letter to AEC Chairman, Glenn Seaborg, Harold Brown, Director of Defense Research and Engineering, formally proposed the lightweight warhead program. Later, a paper titled "MIRV on Minuteman

[95]Betty L. Perkins, "Tracing the Origins of the Modern Primary: 1952-1970 (U)," Los Alamos National Laboratory report LA-13755-H (SRD) (April 2, 2001), pp. XII-7–XII-14.

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1. Loss of the Poseidon C-3 Warhead to Livermore

In March 1965, a paper titled "USN Missile Force Improvement Summary" was published under the sponsorship of the Institute for Defense Analyses. This paper suggested a design for a small reentry vehicle designated the Mk 100 and reported that eight of the Mark 100s could be included in the Navy's Polaris A-3 system.[107]

By April 1965, the Navy decision makers had decided on a new missile to be known as Poseidon. Compared to the Polaris A-3, the Poseidon was to be longer and have a larger diameter, carry a heavier payload, and achieve a greater range. Each missile would carry multiwarheads and would use a space bus to carry and distribute the warheads on target.[108]

A December 6, 1965, letter from the Chief of Naval Operations requested AEC participation in the Poseidon conceptual studies. On the cover sheet of this letter, there is a note written by a person in the Los Alamos management to the effect that Los Alamos had requested that the Navy invite Los Alamos to compete on the Poseidon assignment. The note stated, "...we [LASL] should really go after the business."[109]

On January 13, 1966, Director of Defense Research and Engineering, John S. Foster, Jr., in a letter to AEC Chairman Glenn T. Seaborg indicated that the Navy was favoring the Mk 100-type, small-reentry vehicle with its multiwarheads for use on the new Poseidon C-3 fleet ballistic missile.[110]

Representing the various groups at Los Alamos, on April 28–29, 1966, Peaslee, Aragon, Horpedahl, and Hoverson attended a meeting in Washington on the Poseidon C-3 missile system.

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[107]"USN Missile Force Improvement Summary (U)," Institute for Defense Analyses Pen-X Paper 59, IDA/HQ 65-3610 (SRD) (March 1965), pp. 9–10.

[108]"Weapon Development Status Report (U)," Headquarters Field Command Defense Atomic Support Agency, Sandia Base, Albuquerque, New Mexico report FC/04650121 (SRD) (April 1, 1965), p. 14, A99-019, 160-1.

[109]Harry B. Hahn to Director, Division of Military Application, U.S. Atomic Energy Commission (SRD) (December 6, 1965), 2 pp., A99-019, 217-15.

[110]John S. Foster, Jr. to Honorable Glenn T. Seaborg (SRD) (January 13, 1966), 2 pp., A99-019, 217-15.

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This sample was being analyzed to determine whether the manufacturer's normal procedures would yield a sufficiently pure material.[91]

The Quarterly Status report from the Laboratory for the period ending September 1971 summarizes the previous work on the high-hydrogen materials. The report indicates that various materials containing a high weight-percent of hydrogen in combination with low-Z atoms had been, in the previous two years, exposed to gamma rays from a ^{60}Co source.

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The amount of H_2- or H-containing gaseous products evolved per Mrad of energy absorbed had been measured.

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In terms of the most stable organic compounds studied, the report indicates that LiH was only exceeded in terms of radiation stability by NH_4Cl. But the report also notes, "Because of interest in the hydrogen-rich materials for other weapon applications, properties of the compacted materials such as tensile strength, dimensional stability, pressing characteristics, and compatibility with other components are being investigated."[92]

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(b)(3) p. 22, A86-016, 21-4.

[91] "GMX-2 Monthly Progress Report, August 11 to September 10, 1971," GMX-2-MR-71-9 (SRD) (no date), p. 28, A86-016, 21-3.

[92] "Quarterly Status Report on Weapons Research and Development (U), for the Period Ending September 30, 1971," Los Alamos Scientific Laboratory report LA-4820-PR (SRD) (no date), p. 39.

3. Reservoir Designs to Provide Minimum Helium in the Boost Gas

In a March 1969 memo, primary designer R. Canada outlined the problems that were the result of the formation of ^{3}He from the decay of the tritium used in the primary's boost gas.

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The yield of a boosted primary is degraded as tritium is converted to ^{3}He both by the loss of the source of 14-MeV neutrons and also by the decrease of the pre-boost multiplication rate caused by the high cross-section for neutron capture which is characteristic of ^{3}He." He went on to add, "In a conventional boosted single-stage device the tritium produced by ^{3}He appears too late in the bomb's explosion to contribute to the yield, and the temperature does not get high enough to produce significant ^{3}He + D fusion."[293]

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[293]R. Canada to Distribution, Subject: "^{3}He in Weapons," W-4-2518 (SRD) (March 10, 1969), 5 pp., A99-019, 199-13.

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4. Detonators

a. Test Firing Data

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Historically, various types of detonators have been used, depending upon the type of primary, in the NTS test program. If one type of detonator had been used and it was decided to change to another type of detonator in a similar shot, it was of course necessary to understand any change in the behavior of the new detonator. One way to test any change was to fire the different types of detonators in field tests at Los Alamos.

The GMX-3 progress report for March 16 through April 15, 1969, noted that a request had been given to GMX-8 for a test fire that would compare the 1E30 detonator in a PBX 9407 pellet with the MC-1991 detonator. On April 18, GMX-8 personnel fired the shot. [Author's note: The GMX-8 firing pads were at Kappa site, TA-36.] The GMX-3 progress report stated, "The trace from the 1E30 is not identical with that from the MC-1991; it now remains for us to determine the difference in wave shape and to assess its effect on the system."[316]

Apparently, GMX-8 personnel fired yet another shot. The GMX-3 progress report for May 16 through June 15, 1969, reported that the trace shapes were interchangeable.

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[316] "Group GMX-3 Progress Report (U), March 16 through April 15, 1969," GMX-3-7818 (SRD) (no date), p. 10, A86-016. 32-16.

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Test Fire Data for NTS

B. Pruit Ginsberg, who came to the Laboratory in 1970 to work in GMX-7, recalls that his group leader, Robert L. Spaulding, was a very particular person; his attitude was transmitted to every member of his group. Before each NTS test, several activities took place. Group members of GMX-7 would perform tests to make sure that their firing circuits and detonators were performing properly. These were the confirmation tests. Next Spaulding would send to the staff at PHERMEX a very complete layout of the firing and detonation circuits and all the required specifications. The PHERMEX group could then use this information in setting up any hydro shot that was to be completed for the forthcoming NTS test. Finally, a shot timing memo would be sent out from GMX-7 for use in the NTS event.[319]

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Included are the types of firing units, firing cables, signal cables, and the firing voltage, as well as the type of detonators and the detonator lot used in the firings. Firing data are reported, one for the shot and one for a backup shot.]

b. Early Work Applicable to the 1E33 Detonator Development

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Instead, the detonator group would develop a new type. [Author's note: It will be noted that the 1E30 was an important evolution from earlier detonators in the fact that it was much smaller. Its development, which Ginsberg recalls as being meticulously done, was an important precursor program for the 1E33.]

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[319]B. Pruit Ginsberg, personal communication (SRD) (January 29, 2003).

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Taylor in his history has noted that the "new detonator cable developed by WX-7 was most beneficial."[324]

Today the 1E33 detonator is still in use in the W76. Ginsberg has reported that these detonators show no signs of deterioration with age.[325]

5. Engineering Computer Codes

The WX-3 progress report for November 16 through December 15, 1972, stated in regard to the Mk 400 program, "The SABOR-DRASTIC computer code is now operating correctly for the combined RV/WH models and results were obtained for one of the support schemes."

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By early 1973, the engineers had begun to consider using, for lateral support, a light foam over the entire length of the WH. The results from the SABOR-DRASTIC code runs for this type of mounting were encouraging.[327]

6. Assembly

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[324]John W. Taylor, "The W76 Program: An X-ray View (U)," M-2 TM253 (SRD) (January 8, 1976), p. 70.
[325]B. Pruit Ginsberg, personal communication (SRD) (January 29, 2003).

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[327]"Group WX-3 Progress Report (U), January 16 through February 15, 1973," WX-3-73-97 (SRD) (no date), p. 15 A86-016,-275-1.

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C. Vulnerability

1. Considerations

As the USSR began to develop missiles that carried nuclear weapons, military planners in the United States became concerned that these types of weapons could be used as defense weapons against incoming nuclear-armed missiles from the United States. The question then arose as to how to "harden" the U.S. reentry vehicles and warheads to minimize the impact of this type of Soviet defense.

In addition, it became technically possible in the United States to have one missile carry more than one warhead. As these warheads were released and detonated over a target(s), and if the offensive warheads were detonated too close together during a similar time period, the radiation released from one would affect the others. Again, there was the question of how best to deploy these types of warheads and how to "harden" each warhead from the effects of the others (fratricide).

In response to these problems, scientists in the U.S. weapon complex developed special materials and engineering features designed to minimize the damage (both from radiation and from the shock and heat produced by the interaction of radiation with materials) to a nuclear warhead

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It was necessary to test these designs and materials to see if they met the design objectives. The tests included field-type tests and tests at NTS. In addition, computer codes were developed, based on experimental data, to predict the behavior of components under adverse conditions.

Several types of field tests were employed. In one type of test, shocks were sent into the special materials to study their behavior. Other tests measured the effects of high temperature and similar adverse environments. In another type of test, radiation from a radioactive source, an accelerator, critical assembly, or reactor was used to expose the device to neutrons or x-rays. The type and amount of radiation that could be delivered was dependent upon the irradiating source. These field tests were never able to duplicate an actual exposure environment during deployment.

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The most complex and expensive tests employed were the NTS-type tests. These tests were used to mock-up, in so far as possible, the actual conditions that a warhead might be subjected to. In the following section these vulnerability tests will be briefly described in terms of the specific tests that were relevant to the pre-Phase 3 development of the XW76.

2. NTS Vulnerability Tests

a. Description

NTS vulnerability tests were "effects" tests where the output (neutrons/x-rays) from a detonated nuclear device was used to determine how various weapons, weapon materials, and engineering features would respond should they encounter a hostile environment. This environment might result from the nearby detonation of a nuclear ABM sent by the targeted country or from close detonation of warheads from a U.S. missile in a MIRVed type of deployment. The hostile environment might be encountered at high altitude or near the target.

In this type of NTS test, the sponsoring agency specified what type and level of radiation was required for their experiments. Participating agencies could also specify what exposure would be most useful in their experiments.

Many of the vulnerability tests were sponsored by the Department of Defense/Defense Atomic Support Agency (DOD/DASA). These tests usually had, as noted in Chapter I, double names. Some were sponsored by a weapon laboratory. The sponsoring agency's project managers decided (based on what they wanted in terms of radiation output) on a suitable device. The laboratory (Los Alamos or Livermore) that had designed this device was then asked to provide the device and to assume responsibility for emplacement and detonation of the device. In general, this device was usually a design that had already undergone a previous test(s) where the output radiation had already been determined. If a tested device were not available, a preliminary test to determine specific output might take place at NTS. In addition to supplying and detonating the device, the scientists at the specified laboratory were also responsible for the device diagnostics. In addition, certain diagnostics, for example seismic yield, were done on a routine basis by outside agencies.

Once the nuclear device with its known output had been specified, suitable stations at various distances from the device were set up in the facility in which the experiment was to take place. (Because of the layout required, vulnerability tests were usually done in tunnels at NTS.) The necessary shielding was installed. Instruments to measure the flux of the radiation falling on the samples to be tested were designed, built, and installed. The pieces of equipment or samples for which exposure data were desired were inserted at the specified locations. Special closure assemblies, used to close off the affected region and in theory, prevent bomb debris from spreading into the main tunnel/environment, were designed and installed.

The test configuration with its tunnels, test stations, access holes, and other required facilities could be extremely complex.

(b)(3) The zero room housed the detonated device, firing stand, firing and diagnostics equipment, and front-end closures. (b)(3)

Another line of slight extended from the zero room into an alcove designated "M." The line of sight for the major experimental areas was constructed in a main

drift 925 ft in length. A further 30-foot extension consisting of an arched tunnel housed alcove L. As shown in Figure IV-4, several shafts were used to access the various areas.[333]

John Hopkins, former Test-Division leader, has commented that each layout for a vulnerability test was different. However, all were major efforts in terms of construction and instrumentation.

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b. Test List

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The test layout was designed with three experimental stations in the exposure pipe. An aluminum flux screen was used to cut off, at these stations, x-rays below 10 keV. The latter two stations also included the use of a polyethylene filter to further reduce the flux.

Not only were the various engineering/test groups at Los Alamos responsible for providing the nuclear device and diagnostics, but personnel from J-14 and W-7 along with personnel from EG&G were also responsible for x-ray effects measurements.[337]

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In another Los Alamos experimental set-up, ¾-inch-diameter cylinders, made up of disks of various materials with different thickness layers, were exposed. It was reported that the data obtained in this experiment would allow for the determination of damage thresholds. Another experiment was designed to investigate the thermal limits in various material interfaces. These interfaces included various cross sections of radiation case materials, high-Z loaded plastics, and cylinders of HE.

A listing and description of additional experiments is available in the cited references.[347] Just after the test had been completed, the GMX engineers reported that good data had been obtained; however, the temperatures had been lower than expected.[348]

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[347]John H. McQueen to Cdr. D. D. Swift, TC/DASA, Subject: "Final Report of LASL Data from Experiments Aboard the Hudson Seal Event," J-DO Tech (SRD) (April 21, 1969), 19 pp., A99-019, 265-13. "Program Status Weapons Research and Development, July – September 1968, Part 2 of Two," Los Alamos Scientific Laboratory report DIR-2142 (SRD) (no date), pp. 25–26.

[348]"Group GMX-3 Progress Report, September 16 through October 15, 1968," GMX-3-7455 (SRD) (no date), p. 15, A86-016, 32-10. "W-Division Quarterly Status Report, July 1, 1968 through September 30, 1968, Part 2 of Two," W-2145 (SRD) (October 15, 1968), pp. 41–42, A86-016, 242-7.

3. Calculations

The relevant literature of the late 1960s and early 1970s time period indicates that a very active program was carried on at Los Alamos to calculate the effects of x-rays and neutrons on the Los Alamos weapon designs. These calculations were then compared with the experimental results obtained in the NTS vulnerability tests.

It was reported that the most useful way of expressing the neutron vulnerability of a nuclear weapon was through use of an "F-number." These were customarily expressed in terms of the average number of reactions per kg of material per unit neutron fluence on the exterior of the carrying vehicle. The literature of the period extensively reports on the calculations of F-numbers.

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CHAPTER V. WEAPON PROGRAMS AND CHANGES IN THE STOCKPILE: 1965–MAY 1973

A. Phase 3 Programs at Los Alamos

1. Assignments

a. Phase 3 Programs Entering the Stockpile

During the period 1965–May 1973, the Los Alamos Scientific Laboratory weapon development and design group members were responsible for several Phase 3 weapon programs. [The Phase sequence for weapon programs is noted in Chapter I.] For those weapons that entered the stockpile, the specific weapon program, the date of the Phase 3 award, and the date of the attainment of Phase 6 are as follows:[1]

Weapon Program	Phase 3	Phase 6
B61 Mod 0	June 1963	January 1967
B61 Mod 1		February 1969
B61 Mod 2	August 1971	June 1975
B61 Mod 3	March 1972	October 1979
*W66**	*January 1968*	*October 1974*
W69	January 1967	February 1972
W72	May 1969	September 1970
* Never deployed to the field[2]		

b. Canceled Phase 3 Assignments

In addition to those weapon programs assigned to Los Alamos that were in or went into Phase 3 during the 1965 to 1973 period and entered the stockpile, several Phase 3 programs were assigned to Los Alamos but were later canceled. These were the XW64, XW67, XW73, and XW74.[3]

c. Discussion

The Phase 3 weapon programs under development at Los Alamos from 1965 through May 1973 will be discussed in the following sections. Each section will cover a specific weapon.

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[1]"FY 1994 Annual Weapons Program Report," DOE Albuquerque Operations Office report (SRD) (October 1, 1994), pp. 25–26, 301, 309, 326.

[2]"FY 1994 Annual Weapons Program Report," DOE Albuquerque Operations Office report (SRD) (October 1, 1994), p. 301.

[3]Betty L. Perkins, "Why Nougat? (U)," Los Alamos National Laboratory report LA-12950-H (SRD) (November 1, 1995), p. A-3.

2. Weapon Programs

a. B61

While the Phase 3 assignment for the B61 Mod 0 was received by the Los Alamos Scientific Laboratory in 1963, the Los Alamos weapon groups were going to find that they would have an extended development program for this weapon. The B61 would go through many models and deployment objectives over a period of many years. Several Mods of this bomb, in modified designs from the ones that were first developed, are still in the U.S. nuclear weapon stockpile.

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The B61 Mod 0, 2, and 5 bombs would be carried by U.S. Navy A-6E and F/A-18A/C/D aircraft. These bombs would also be carried by U.S. Air Force F-16 A/B/C/D and F-111 D/E/F aircraft. The later Mod 3, 4, and 10 variations would be carried by U.S. Air Force F-16 A/B/C/D and F-111 D/E/F aircraft as well as F117-A aircraft. The Mod 3, 4, and 10 bombs would also be carried on NATO F-16 A/B aircraft and on Tornado aircraft. A recent version (Mod 7) is carried on the Air Force B-2A and B52-H. As the different Mods were introduced into the stockpile, many additional safety features would be included. The early Mod 0-Mod 2 designs discussed in this section have been retired from the stockpile or converted.[4]

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The B61 Mod 0 and Mod 1 weighed 715 lb and had a diameter of 13.3 inches and a length of 141.6 inches. The B61 Mod 0 first entered the stockpile in January 1967.

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[4]"FY 1994 Annual Weapons Program Report," DOE Albuquerque Operations Office report (SRD) (October 1, 1994), pp. 25, 29.

b. XW64

In May 1964, the Military Characteristics for nuclear warheads for the Lance Missile system were issued. This missile was to be a surface-to-surface missile for use by the Army. Both Los Alamos and Livermore submitted proposals for this warhead. As it would turn out, both Laboratories would initially receive the authorization to proceed. The XW64 was the nomenclature given to the Los Alamos design; XW63 was the nomenclature given to the Livermore design.

Los Alamos received the authorization to proceed with the development of the XW64 on July 20, 1964

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However, the initial authorization was soon withdrawn. Attempts were made by the Los Alamos management in 1966 to have the program reactivated.[77] But neither the XW63 nor the XW64 was ever produced.

The final warhead, that provided a nuclear capability for the Army's surface-launched guided missile (MGM-52C) known as Lance, was the W70. The Phase 3 assignment for the W70 warhead was given to Livermore in April 1969

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c. W66

The W66 was a two-stage thermonuclear warhead designed for use on the Sprint missile. This missile was a short-range, low-altitude, quick reaction intercept missile. Therefore, the missile had high launching and maneuvering accelerations and a very short reaction time between launching and the firing of the warhead.

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The Sprint missile/warhead was part of the Safeguard weapon system.

The AEC laboratories originally received the Phase 3 authorization for the development of the warhead for the Sprint missile system in September 1965.

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[77]N. E. Bradbury, Los Alamos Scientific Lab., Los Alamos, N.M. to Brig. Gen. Delmar L. Crowson, DMA, USAEC, Wash., D. C., DIR-2017 (CRD) (February 14, 1966), p. 1, A99-019, 217-7.

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g. XW73

The Condor was a proposed Navy missile. It was to be a TV-guided, rocket-powered, air-to-surface missile. The warhead for this missile was designated the BA73. Initially, two versions of the warhead were to be provided.

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The initial plans for the warhead were to use a slightly modified W69.[182]

The Condor Development Authorization notice for the nuclear warhead section is dated July 15, 1969.[183] However, Giller, in a November 24, 1969, TWX to the Laboratory, noted that the Initial Operational Capability (IOC) date for the Condor warhead had been delayed. The Laboratory was instructed to study all the possible alternatives in the design and development of nuclear systems for the Condor.[184]

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A letter dated July 13, 1970, to the Chairman of the AEC from the DDR&E (Director, Defense Research & Engineering) states, "Recent program reviews have resulted in a decision to delay a commitment to production of the Condor missile system until the completion of system engineering development and operational evaluation. This action will also delay the Navy support for the nuclear warhead development program until approximately September 1972 when further Condor program decisions can be expected." The letter also notes, "It may be prudent for the AEC to stop all nuclear Condor development activity until a Navy commitment to production is made." However, it did appear that some developmental activities might have to continue if the Condor warhead were to become operational as early as January 1975.[187]

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[182]"Program Status Weapons Research and Development July– September 1969 (U)," Los Alamos Scientific Laboratory report DIR-2187 (SRD) (no date), p. 61. "W-Division Quarterly Status Report, July 1, 1969 through September 30, 1969," W-2217 (SRD) (October 15, 1969), p. 27, A86-016, 242-11.

[183]H. C. Donnelly, Manager, Albuquerque Operations Office, AEC to N. E. Bradbury, Director, LASL and J. A. Hornbeck, President SLA, Subject: "Condor Development Authorization," (CRD) (July 15, 1969), 2 pp., A99-019, 198-11.

[184]*USAEC, Edward Giller, Wash., D.C. to USAEC, H. C. Donnelly (SRD) (November 24, 1969), 3 pp., A99-019, 218-18.*

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[187]USAEC, Edward B. Giller, Wash., D.C. to AN3, USAEC, H. C. Donnelly, Albuquerque, N.M. et. al., (CRD) (July 31, 1970), 2 pp., A99-019, 39-7.

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The AEC and the Navy then apparently decided to suspend specific warhead development until the Condor missile was farther along in its development. It was felt that not to do so might result in a "less than optimum nuclear warhead" to interface with the missile. In October 1970, it was reported that the W73 was in a suspended Phase 3. Future development efforts were uncertain.[189]

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[189]"Weapons Program Study and Development Report," Headquarters Field Command, Defense Atomic Support Agency, Sandia Base, Albuquerque, New Mexico report FC10700038 (SRD) (October 1, 1970), p. 26.

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The Advanced Planning Document for the W73 was issued in October 1971.

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The third quarter report for 1972 from the Laboratory states, "The insertable-capsule (IC) concept has recently interested the AEC and DoD for several convertible warhead applications. The convertible WH uses a conventional HE warhead, which, if necessary can be converted to a nuclear warhead by inserting a fissionable core. ...Some of the more interesting applications are for Harpoon, the Modular Guided Glide Bomb, Condor, the Mk 48 and Mk 46 torpedoes, and the Mk 84 bomb." It was also noted, "LASL is working on a proposed program to field a nuclear test of a device representative of the IC, convertible-warhead concept before June 30, 1973."[196]

Despite the initial warhead development program discussed briefly in the previous paragraphs, the warhead was never produced.

h. XW74

The XW74 was an Army-Navy-proposed 155-mm projectile. The project was canceled in June 1973 at the end of the Phase 3, which had been awarded to Los Alamos.

The Laboratory status report for weapons for the period January–March 1969 notes that a Phase 2 feasibility study for a new 155-mm nuclear round for the Army was nearing completion. Two designs had been proposed.

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[196]Leslie M. Redman and Cecil C. Carnes, Jr., "Quarterly Status Report on Weapons Research and Development for the Period Ending September 30, 1972 (U)," Los Alamos Scientific Laboratory report LA-5130-PR (SRD) (January 1973), p. 72.

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The Laboratory's status report for that period gives detailed information on the material problems that would have to be solved should the design be a successful one.[199]

The Phase 3 for the W74 warhead was initiated on October 28, 1969.[200] The Laboratory was assigned engineering development responsibility on February 24, 1970.[201]

The Laboratory status report for January–March 1970 reports, "Authorization to proceed with a Phase 3 development program for a 155-mm AFAP [Artillery Fired Atomic Projectile] was received from DMA on February 24. The list of approved Military Characteristics and the *Army Stockpile to Target Sequence were received in early March. The Army nomenclature for* the AFAP is XM-517. AEC nomenclature for the nuclear warhead is W74.

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The January 1 through March 31, 1970, W-Division report indicates that engineering design and field test efforts were continuing for this project.

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During the spring of 1970, design and procurement of components for the local hydrodynamic shots was reported as proceeding on schedule. Special high-pressure materials were undergoing development.[204]

During the summer of 1970 various specific pit designs were studied for use in the XW74.

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A structural test plan was outlined. Stress analysis was being performed using the

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[199] "Program Status Weapons Research and Development October – December 1969 (U)," Los Alamos Scientific Laboratory report DIR-2195 (SRD) (no date), p. 65.

[200] "Nuclear Technology and Analysis Report (U)," Field Command Defense Nuclear Agency, Kirtland Air Force Base, New Mexico 87115 report HQDNA-185M, (SRD) (August 1, 1972), p. 32, B11, Drawer 57, Folder 1 of 2.

[201] USAEC, Edward B. Giller, Wash., D.C. to C13, N. E. Bradbury, LASL, Los Alamos, N.M., BW3, M. M. May, LRL. Livermore. Calif. (CRD) (February 24, 1970). 1 p., A99-019, 198-12.

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[204] "W-Division Quarterly Status Report, April 1, 1970 through June 30, 1970," W-2264 (SRD) (July 15, 1970), p. 40, A86-016, 242-13.

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SAAS II code

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During the first quarter of 1971 engineering design work continued. The status report from W-Division for January 1 to March 31. 1971 notes that the examination of alternate case materials was continuing.[207]

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The Laboratory's status report ending March 1971 indicates that two concepts relevant to nonviolent disablement had been investigated theoretically. The report also notes, "The AEC production schedule for the W74 has slipped because of funding problems. The date of the Phase 5 is now December 1974 and for the Phase 6 is March 1975."[209] The Laboratory's status report ending June 1971 reports that weapon denial schemes were continuing to be investigated.

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[207] "W-Division Quarterly Status Report, January 1, 1971 through March 31, 1971," W-2318 (SRD) (April 15, 1971), pp. 19–20, A86-016, 242-16.

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[209] "Quarterly Status Report on Weapons Research and Development for the Period Ending March 31, 1971 (U)," Los Alamos Scientific Laboratory report LA-4680-MS (SRD) (May 1971), pp. 38–39.

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Engineering design and test activities had also continued during the summer.

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In early November the design/engineering teams had begun the next iteration towards producing a weaponized device.

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However, these tests were very useful in guiding the design of the XW74.[427]

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[427]R. K. Osborne and M. T. Thieme, "Theoretical Design of Implosion Weapons, 1959-1980 (U)," *Defense Research Review*. UCRL 53880-4-2 (SRD) (July 1992). p. 72.

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Improved Small Atomic Demolition Munition (SADM)

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e. Projectiles

175-mm and 8-in. Projectiles

(b)(3)

It appeared that a redesigned 8-in. shell with the same ballistic characteristics as the conventional 8-in. shell or a rocket-assisted 8-in. shell could also be developed.

There had been a lack of a specific interest by the Army for either the 175-mm or 8-in. shell projectiles. The Laboratory's yearly report noted that the Los Alamos groups had reduced their effort on these types of designs to "essentially zero."[287]

155-mm Projectile

(b)(3)

[287] "LASL Program for Fiscal Years 1967-1968," DIR-2029 (SRD) (no date), p. 33.

(b)(3)

3. 1967

a. (b)(3)

Spitfire (Spartan)

By 1967, Spitfire had evolved into a program called Spartan. A report dated February 7–8, 1967, reported, "The present LASL SPITFIRE Test Program is directed toward developing a warhead for the SPARTAN Missile. To shorten the warhead development time scale, the tests are being performed in as near a weaponized configuration as possible."[290] (This program would later become part of the Safeguard program described in a following section.)

(b)(3)

A memo from Jane Hall noted that during the October 25, 1967, WLPC meeting Bradbury and Agnew had reported on the October 23, 1967, Spartan meeting that had been held in Washington. The two had reported that General Giller (Assistant General Manager for Military Application) had indicated that he expected LASL and LRL to propose a pie-split in the Spartan program.

(b)(3)

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[290] "Minutes of the First Meeting Spartan Ad Hoc Interface Working Group," (SRD) (February 7-8, 1967), p. 13, A99-019, 227-18.

(b)(3)

(b)(3)

A Sandia paper dated November 16,1967, noted that a follow-on Spartan program was also being considered.

(b)(3)

The Sandia paper stated, "This follow-on Spartan will supplement, but not replace the Spartan."[295]

It appears that by December 1967, the management at the Laboratory was beginning to consider the fact that the LASL would probably be assigned the Sprint program and Livermore would receive the Spartan (b)(3)

Sea-Based Ballistic Missile Intercept System

Also under consideration at that time was the design of a warhead for the Sea-Based Ballistic Missile Intercept System (SABMIS).[297]

Scampi

(b)(3)

[295] "Follow-On Spartan," Sandia report RS 5624/52 (SRD) (November 16, 1967), p. 1, A99-019, 227-18.

(b)(3)

[297] "LASL Program for Fiscal Years 1968-1969," DIR-2081 (SRD) (May 21, 1967), p. 19.

(b)(3)

[301] "LASL Program for Fiscal Years 1968-1969," DIR-2081 (SRD) (May 21, 1967), pp. 19–20.

(b)(3)

This effort will be discussed in the final chapter of this report.[302]

(b)(3)

Walleye

There was a Phase 2 study of a warhead for the Walleye glide bomb.

(b)(3)

SAM-D

A Phase 2 study for a primarily mobile field Army air defensive system was expected. This was to be called the SAM-D missile.[303]

e. Projectiles and Earth-Penetration Weapons

175-mm and 8-in. Shells

(b)(3)

However, it was reported, "...lack of specific interest by the Army has reduced this activity to essentially zero. A hardware program which uses 8-in. projectiles in earth penetrating weapons is being done in collaboration with the Sandia Corp."[304]

155 mm

There continued to be interest in the 155-mm projectile program.[305]

(b)(3)

After evaluation of the data, it appeared that further engineering improvements were needed.[307]

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[302] "LASL Program for Fiscal Years 1968-1969," DIR-2081 (SRD) (May 21, 1967), pp. 20–21.

[303] "LASL Program for Fiscal Years 1968-1969," DIR-2081 (SRD) (May 21, 1967), p. 21.

[304] "LASL Program for Fiscal Years 1968-1969," DIR-2081 (SRD) (May 21, 1967), p. 23.

[305] *"W-Division Quarterly Status Report, April 1, 1967 through June 30, 1967, Part 2 of Two," W-2035 (SRD)* (July 17, 1967), pp. 1–15, A86-016, 242-2.

(b)(3)

[307] "W-Division Quarterly Status Report, October 1, 1967 through December 31, 1967, Part 2 of Two," W-2084 (SRD) (January 15, 1968), pp. 17–20, A86-016, 242-4.

(b)(3)

Bayonet

Reported in the third quarter report for 1967 from W-Division was a proposed program called Bayonet. The report states, "Bayonet is a program to determine the feasibility of using a nuclear warhead in an air-dropped weapon which can be exploded after the weapon has impacted and penetrated the ground." The warhead compartment had a diameter of approximately 6.5 inches. The report from W-Division also indicates that the first Bayonet warhead had been drop-tested at Tonopah.[309]

The fourth-quarter report from W-Division notes that the second complete Bayonet assembly had, in October 1967, been drop-tested at the Tonopah Test Range. The missile had not penetrated properly, and the warhead had been damaged. It was stated that Sandia Corporation would correct the missile deficiencies before additional drop tests were made. However, based on the available data, it appeared that if the missile survived, the warhead would survive and would be able to function after impact.[310]

f. Nonnuclear Kill

(b)(3)

4. 1968

(b)(3)

The defense program aimed at early destruction of an incoming missile carrying a nuclear warhead was now called Spartan. The Spartan missile was to be deployed on a trajectory that intercepted the enemy's incoming missile above the atmosphere

(b)(3)

[310] "W-Division Quarterly Status Report, October 1, 1967 through December 31, 1967, Part 2 of Two," W-2084 (SRD) (January 15, 1968), pp. 13–15, A86-016, 242-4.

(b)(3)

The Spartan and Sprint missiles together formed what was by this time period being called the Sentinel program. The Spartan was the device that was to be the initial high-altitude defense for destroying the incoming missile. The Sprint was to be the low-altitude backup device.

In January 1968, the responsibility for continued Phase 3 development of the Sprint warhead was transferred from Livermore to Los Alamos. This warhead was designated XW66. The primary responsibility for development of the Spartan warhead was assigned to Livermore. This warhead was designated XW71. However, the Los Alamos Laboratory was given a backup role for Spartan. The assignment memo from Assistant General Manager for Military Application Brig. Gen. Giller stated, "Los Alamos Scientific Laboratory/Sandia Corporation-Sandia Laboratory are to continue development of the SPITFIRE device as a backup warhead with warhead characteristics and schedules compatible with the SPARTAN program."[312]

(b)(3)

[The latter two tests are included in the following paragraphs.]

(b)(3)

[312]Brigadier General Edward B. Giller, USAF, Assistant General Manager for Military Application, Headquarter, to Those listed below, Subject: "Laboratory Assignments for Development of Sentinel Warheads," (CRD) (January 22, 1968), 2 pp., A99-019, 1980-9. "LASL Program for Fiscal Years 1969-1970," DIR-2143 (SRD) (October 1, 1968), p. 12.

(b)(3)

(b)(3)

It was noted that very favorable results had been obtained from this experiment."[318]

(b)(3)

Advanced Spartan

An Advanced Spartan was also being considered in 1968. The third-quarter W-Division status report notes, "The first meeting of the Phase one AEC/DOD Advanced ABM Coordinating Group was held at AEC/DMA.

(b)(3)

[318]"W-Division Quarterly Status Report, April 1, 1968 through June 30, 1968, Part 2 of Two," W-2128 (SRD) (July 15, 1968), pp. 39–42, A86-016, 242-6.

(b)(3)

(b)(3)

Safeguard: Follow-On Sprint

The second quarter report from W-Division notes that a joint SLA/LASL document was being prepared that would summarize the Follow-On Sprint programs at the two Laboratories.[328] The W-Division quarterly report for July 1 through September 30, 1968, announced that a LASL/SLA program for the Follow-On Sprint was being studied. Design layouts were being prepared for two warhead proposals for the Upstage II interceptor that was a Follow-On Sprint variation.

(b)(3)

[328]"W-Division Quarterly Status Report, April 1, 1968 through June 30, 1968, Part 2 of Two," W-2128 (SRD) (July 15, 1968), p. 11, A86-016, 242-6.

(b)(3)

SCAD (Subsonic Cruise Armed Decoy)

(b)(3)

Meetings were being held in preparation for the Phase 2 meeting.[343] It was reported that drafts of the General Requirements for SCAD and the Phase 1 data package had been received from the Air Force Weapons Laboratory.[344]

MRV (Maneuvering Reentry Vehicle) and ARV (Advanced MRV)

The second quarter W-Division report notes, "Aerospace Corporation briefed the weapons laboratories on the status of the MRV program and requested preliminary warhead designs."[345]

A joint SLA/LASL data package was prepared for the Maneuvering Reentry Vehicle (MRV) program. (b)(3)

By the end of the year, the program had become the Advanced MRV (ARV). The working group for the ARV had been organized in a meeting on October 3, 1968; the first meeting of this working group had been held on December 2, 1968. (b)(3) However, despite this interest in the program, it was noted that ARV prototype development contracts were going to be delayed a year or more.[347]

MARS

There was also consideration of a system called MARS. This was a system to be mounted on armored vehicles.

(b)(3)

BDM (Bomber Defense Missile) and DPM (Dual-Purpose Missile)

Also in this long "want" list from the Military was the Air Force interest in a Bomber Defense Missile (BDM) and a Dual-Purpose Missile (DPM). The Dual-Purpose Missile was to be a ramjet-propelled missile with a velocity of Mach 4 to 4.5 and a range of 300 miles.[349]

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[343]"Program Status Weapons Research and Development, October-December 1968, Part 2 of Two," DIR-2156 (SRD) (no date), p. 9.

[344]"W-Division Quarterly Status Report, October 1, 1968 through December 31, 1968, Part 2 of Two," W-2164 (SRD) (January 15, 1969), pp. 16–17, A86-016, 242-8.

[345]"W-Division Quarterly Status Report, April 1, 1968 through June 30, 1968, Part 2 of Two," W-2128 (SRD) (July 15, 1968), p. 13, A86-016, 242-6.

(b)(3)

[347]"W-Division Quarterly Status Report, October 1, 1968 through December 31, 1968, Part 2 of Two," W-2164 (SRD) (January 15, 1969), p. 12, A86-016, 242-8. "Program Status Weapons Research and Development, October-December 1968, Part 2 of Two," DIR-2156 (SRD) (no date), p. 8.

(b)(3)

[349]"Program Status Weapons Research and Development, October-December 1968, Part 2 of Two," DIR-2156 (SRD) (no date), p. 8.

(b)(3)

Los Alamos supplied the Air Force Weapons Laboratory with a list of 20 possible warhead candidates for these applications.[350]

By the fourth quarter of 1968, meetings had been held with representatives of the Office of Research Analysis and AFWL.

(b)(3)

LAR (Low-Angle Reentry Vehicle)

The first quarter 1968 report from W-Division notes that a technical data package on a LAR (Low-Angle Reentry Vehicle) had been submitted to AFWL for submission to Air Force contractors.

(b)(3)

During the spring, meetings were held with DOD agencies and contractors to discuss the warhead proposals contained in the LASL Phase 1 data-package.[353]

(b)(3)

The final quarter report for the year from W-Division states, "A DoD contractor has completed the evaluation and pre-design study of the Low Angle Reentry Vehicle concept

(b)(3)

Primaries

(b)(3)

[350] "W-Division Quarterly Status Report, July 1, 1968 through September 30, 1968, Part 2 of Two," W-2145 (SRD) (October 15, 1968), p. 12, A86-016, 242-7.

(b)(3)

[353] "W-Division Quarterly Status Report, April 1, 1968 through June 30, 1968, Part 2 of Two," W-2128 (SRD) (July 15, 1968), p. 11, A86-016, 242-6.

(b)(3)

ADM (Atomic Demolition Munition) and ADAM (Advanced Atomic Demolition Munition

There was interest in an Atomic Demolition Munition (ADM) for the Army.

(b)(3)

The second quarter 1968 report from W-Division notes that the second meeting concerning a possible ADM had been held on May 21–23.[359] LASL proposals were submitted in response to the requirements that had been outlined at the first meeting.

(b)(3)

'A nonnuclear self-destruct was to be included.)"[360] The third quarter 1968 report from W-Division notes that the ADM proposals were being updated.[361]

During the latter part of 1968, the Army-approved requirements for an Advanced Atomic Demolition Munition (ADAM) were received at Los Alamos.[362]

(b)(3)

The final quarter 1968 report from W-Division states that a Phase 2-type data package was being prepared.[364]

Walleye

The first quarter report from W-Division states, "LASL is currently working with ALOO to re-do the Walleye Phase 2 cost data study prepared in January 1967. DMA is requesting detailed laboratory manpower and material cost estimates for these proposals and on all future Phase 2 studies."[365] [The reader will recall that the Walleye was an electro-optical guided glide bomb. It was designed for use by the Air Force's F-4D aircraft.]

It was felt that a Phase 3 development program for the Walleye might be authorized in FY 1969.[366] [The reader will recall that the Phase 3 was assigned in May 1969. The warhead would be given the nomenclature XW72.]

(b)(3)

[359]"W-Division Quarterly Status Report, April 1, 1968 through June 30, 1968, Part 2 of Two," W-2128 (SRD) (July 15, 1968), p. 10, A86-016, 242-6.

[360]"Program Status Weapons Research and Development, April-June 1968, Part 2 of Two," DIR-2133 (SRD) (no date), p. 7.

[361]"W-Division Quarterly Status Report, July 1, 1968 through September 30, 1968, Part 2 of Two," W-2145 (SRD) (October 15, 1968), p. 11, A86-016, 242-7.

[362]"Program Status Weapons Research and Development, October-December 1968, Part 2 of Two," DIR-2156 (SRD) (no date), p. 8.

(b)(3)

[364]"W-Division Quarterly Status Report, October 1, 1968 through December 31, 1968, Part 2 of Two," W-2164 (SRD) (January 15, 1969), p. 11, A86-016, 242-8.

[365]"W-Division Quarterly Status Report, January 1, 1968 through March 31, 1968, Part 2 of Two," W-2104 (SRD) (April 15, 1968), p. 8, A86-016, 242-5.

[366]"LASL Program for Fiscal Years 1969-1970," DIR-2143 (SRD) (October 1, 1968), p. 14.

Sparrow

There were also discussions with the Air Force Weapons Laboratory on providing a warhead for what was called an Advanced Sparrow missile.[367]

d. Projectiles and Earth-Penetrating Weapons

Bayonet

The program called Bayonet continued in 1968. The concept at this time was for this device to include a shaped charge of HE that was designed to detonate when the missile was a few feet from the ground. The ensuing jet was supposed to penetrate the earth, and in theory, enable an easier entry for the nose of the missile. The problem with the concept was how to penetrate hard rock.[368]

The second quarter W-Division report indicates that further work and redesign of the system had taken place in the reporting period of April 1–June 30, 1968. The report notes, "Except for the additional tests of the redesigned internal ballistic system, the planned Bayonet feasibility program has been completed."[369]

(b)(3)

[367]"Program Status Weapons Research and Development, April-June 1968, Part 2 of Two," DIR-2133 (SRD) (no date), p. 8. "W-Division Quarterly Status Report, July 1, 1968 through September 30, 1968, Part 2 of Two," W-2145 (SRD) (October 15, 1968), p. 11, A86-016, 242-7.

[368]"Program Status Weapons Research and Development, July-September 1968, Part 2 of Two," DIR-2142 (SRD) (no date), p. 9.

[369]"W-Division Quarterly Status Report, April 1, 1968 through June 30, 1968, Part 2 of Two," W-2128 (SRD) (July 15, 1968), pp. 14–15, A86-016, 242-6.

(b)(3)

155-mm

(b)(3)

8-inch

An in-house meeting was held in Albuquerque in November for the purpose of considering a new 8-inch artillery-fired atomic projectile (AFAP). The Phase 2 meeting was held in December. It was reported that it had been concluded that a new nuclear warhead was feasible.[375]

e. Nonnuclear Kill

(b)(3)

[375] "Program Status Weapons Research and Development, October-December 1968, Part 2 of Two," DIR-2156 (SRD) (no date), p. 9. "W-Division Quarterly Status Report, October 1, 1968 through December 31, 1968, Part 2 of Two," W-2164 (SRD) (January 15, 1969), p. 16, A86-016, 242-8.

(b)(3)

Steel Rods

There was also interest by the Air Force in a technique of nonnuclear kill of reentry vehicles using high-velocity (4,000–6,000 m/s) 50-g steel rods. These would be accelerated using a nuclear detonation. It was hoped that retired W59 warheads could be modified for use in the program.[377]

The year-end quarterly report from the Laboratory notes that two W59 warheads were being modified for tests.[378] The year-end quarterly report from W-Division states, "The extent of LASL participation in this program is to review the test and packaging procedures for nuclear safety hazards and post-test assessment of warhead damage."[379]

5. 1969

(b)(3)

Backup Spartan

In a letter dated January 28, 1969, from the AEC, the Laboratory was informed, "This office has been informally advised by DMA that the LASL Spartan backup device has been deleted from the STS program." The letter added, "Accordingly, it is requested that you examine your STS support requirements in order to gain an early appreciation of those items that might be affected by this change."[380]

(b)(3)

[377]"Program Status Weapons Research and Development, April-June 1968, Part 2 of Two," DIR-2133 (SRD) (no date), p. 8. "W-Division Quarterly Status Report, July 1, 1968 through September 30, 1968, Part 2 of Two," W-2145 (SRD) (October 15, 1968), p. 12, A86-016, 242-7.

[378]"Program Status Weapons Research and Development, October-December 1968, Part 2 of Two," DIR-2156 (SRD) (no date), p. 8.

[379]"W-Division Quarterly Status Report, October 1, 1968 through December 31, 1968, Part 2 of Two," W-2164 (SRD) (January 15, 1969), pp. 11–12, A86-016, 242-8.

[380]Robert E. Miller to W. D. Smith, Jr. et. al., Subject: "STS Program Adjustment," (CRD) (January 28, 1969), 1 p., A99-019, 218-4.

(b)(3)

(b)(3)

Improved Spartan

(b)(3)

The LASL warhead proposals for an Improved Spartan program were outlined in detail in an April 21, 1969, paper.[385]

(b)(3)

However, the W-Division report for April–June notes that it appeared that the Phase 2 study was going to be delayed.[386]

The Laboratory's quarterly report of July–September 1969 indicates that while the final Phase 3 Spartan missile warhead development for the Safeguard program had gone to Livermore as the W71, the Los Alamos teams were continuing to work on the development of an Improved Spartan—a follow-on program to the Spartan.

(b)(3)

It was expected that the Phase 1 data package for the Improved Spartan would be forwarded to the DDR&E (Director, Defense Research and Engineering) around October 1.[387] The W-Division report for July–September 1969 indicates that in July the Safeguard System Command had published a

(b)(3)

[385]"LASL Warhead Proposals for Improved Spartan Program," W-9-390 (SRD) (April 21, 1969), 5 pp., A99-019, 218-4.

[386]"W-Division Quarterly Status Report, April 1, 1969 through June 30, 1969, Part 2 of Two," W-2199 (SRD) (July 15, 1969), p. 21, A86-016, 242-10. "Program Status Weapons Research and Development, April – June 1969, Part 2 of Two (U)," DIR-2180 (SRD) (no date), p. 11.

[387]"Program Status Weapons Research and Development, July - September 1969 (U)," DIR-2187 (SRD) (no date), pp. 46–47, 61.

schedule for the development of a warhead section for the Improved Spartan. The Phase 1 report was to be completed by September 1969 and the Phase 2 by January 1970. However, it appeared that this schedule was slipping.[388]

(b)(3)

Additional information is available in the cited reference.[391]

SABMIS (Sea-Based Ballistic Missile Intercept System)

A January 9,1969, TWX from the Assistant General Manager for Military Application, Edward B. Giller, reported that the DOD was studying the SABMIS concept in order to add depth to the defenses of the continental U.S. In addition, SABMIS had the advantage that it would be a mobile system that would be available for the defense of an overseas area; nuclear weapons would not have to be deployed ashore.

(b)(3)

[388] "W-Division Quarterly Status Report, July 1, 1969 through September 30, 1969," W-2217 (SRD) (October 15, 1969), p. 14, A86-016, 242-11.

(b)(3)

[391] "W-Division Quarterly Status Report, April 1, 1969 through June 30, 1969," W-2198 (SRD) (July 15, 1969), pp. 50–58, A86-016, 242-10.

(b)(3)

(b)(3)

The final W-Division quarterly report for 1969 states that the Phase 1 data-package for the Mk 19 had been reviewed on October 16, 1969, during a meeting at the Air Force Weapons Laboratory. It appeared that the program would go to Phase 2. The Air Force Scientific Advisory Board had received a review of the LASL program.

(b)(3)

[Author's note: The Mk 19 program would be the precursor to the XW78.]

New Full Fusing Option (FUFO) Bomb

(b)(3)

In a Phase 1 study, the weapon laboratories had outlined the possibilities for this type of bomb in terms of yield, size, and weight.[401]

(b)(3)

LORAH (Long Range Area Homer)

During the first quarter of 1969, it was reported that preliminary studies had been conducted by the Advanced Ballistic Missile Defense Agency and its contractors on future missile defense systems. A system-concept known as Long-Range Area Homer (LORAH) had been selected for more detailed study.[403]

(b)(3)

[401] "W-Division Quarterly Status Report, October 1, 1969 through December 31, 1969," W-2235 (SRD) (January 15, 1970), p. 42, A86-016, 242-12.

(b)(3)

[403] "Program Status Weapons Research and Development, January – March 1969, Part 2 of Two (U)," DIR-2172 (SRD) (no date), p. 12. "W-Division Quarterly Status Report, January 1, 1969 through March 31, 1969, Part 2 of Two," W-2193 (SRD) (April 15, 1969), p. 22, A86-016, 242-9.

During the second quarter, Los Alamos personnel supplied basic warhead data to attendees at a joint AEC/DOD meeting.[404] The second quarter 1969 W-Division report states for the LORAH system, "Initial design parameters of the proposed missile delivery system indicate that a small nuclear yield will meet the target kill requirements if the small miss distance (≈30–50 ft versus the 50–100 ft previously stated as a design goal) can be provided by the guidance/homer system now under study for the LORAH system."[405]

The fourth quarter W-Division report for 1969 notes that in a three-day meeting held during the first part of November, the studies on LORAH, completed by three different contractors, had been presented to the Advanced Ballistic Missile Defense Agency. The results of the three studies had been almost identical. The interceptor would carry 4 to 6 vehicles to an intercept point after which an interceptor-borne sensor would identify targets. As targets were identified, a homing sensor would lock on and would "zero in on the target." The high accuracy of hitting the target would permit the use of very low-yield warheads. It was noted, "The LORAH concept is under study for the 1980s to operate in conjunction with the SAFEGUARD defense system."[406]

Bomber Defense Missile, Dual-Purpose Missile

During January–March 1969, discussions were continued with personnel from the Air Force Weapons Laboratory and their contractors on warhead proposals for the Bomber Defense Missile (BDM) and the Dual Purpose Missile (DPM). It was noted that yields of 1- to 10-kt were of interest for the BDM; yields of 5- to 200-kt were of interest for the DPM.[407]

During the second quarter of 1969, a joint LASL/SLA information document (as input for a study of possible warheads for the DPM) was submitted to the AFWL.

(b)(3)

The Laboratory status report for July–September 1969 notes that the final report on the DPM had been completed by the Office of Research Analysis of the U.S. Air Force. The W-Division quarterly report notes, "LASL has received volumes 1, 2, 3, 4, 6 and 9 of this extensive report. This report recommends further investigation on air-breathing propulsion, missile guidance, and low radar cross sections."

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[404] "Program Status Weapons Research and Development, April – June 1969, Part 2 of Two (U)," DIR-2180 (SRD) (no date), p. 10.

[405] "W-Division Quarterly Status Report, April 1, 1969 through June 30, 1969, Part 2 of Two," W-2199 (SRD) (July 15, 1969), p. 19, A86-016, 242-10.

[406] "W-Division Quarterly Status Report, October 1, 1969 through December 31, 1969," W-2235 (SRD) (January 15, 1970), p. 37, A86-016, 242-12.

[407] "Program Status Weapons Research and Development, January – March 1969, Part 2 of Two (U)," DIR- 2172 (SRD) (no date), p. 11. "W-Division Quarterly Status Report, January 1, 1969 through March 31, 1969, Part 2 of Two," W-2193 (SRD) (April 15, 1969), p. 19, A86-016, 242-9.

(b)(3)

The fourth quarter 1969 report from W-Division states that the Air Force had approved a funded design study for a Short Range Bomber Defense Missile. The Los Alamos weapon groups in support of this study had sent warhead information to the Air Force Weapons Laboratory.[410]

SCAD (Subsonic Cruise Attack Decoy)

Early in 1969, preparations continued for an anticipated AEC/DOD Phase 2 meeting on the Subsonic Cruise Attack Decoy (SCAD).

(b)(3)

The July–September quarterly reports prepared by the Laboratory groups announced that three contractors were making further feasibility studies, to be completed by September 30, 1969, on the SCAD proposal.

(b)(3)

It was stated, "Studies have been made to determine whether a particular combination will give a significant range advantage to the SCAD.

(b)(3)

ARV (Advanced MRV)

It was announced that the Air Force had awarded identical ARV contracts effective May 1, 1969 to two contractors. These were for the purpose of evaluating flight control system concepts for Terminal Evasion/Accuracy and for Terminal-Evasion-only MRVs. [The ARV program had been extended to include studies of a Simple Terminal Evasion (STE) vehicle as well as the Terminal Evasion/Accuracy vehicle.]

(b)(3)

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[410] "W-Division Quarterly Status Report, October 1, 1969 through December 31, 1969," W-2235 (SRD) (January 15, 1970), p. 40, A86-016, 242-12.

(b)(3)

The third quarter report from Los Alamos notes that in the planning considerations, the Panther A primary had been used in the baseline design for the Terminal Evasion/Accuracy MRV. Two technical exchange meetings had been held in August.[415]

The final quarter report for 1969 from W-Division indicates that, in support of the ARV program, personnel from LASL had attended the Technical Direction meetings with the Air Force and their two contractors. The present ARV study program, with the primary goal of evaluating flight control systems, was scheduled for completion in February 1970.[416]

ASMA (Advanced Surface Missile)

During the second quarter of 1969, it was reported that an Advanced Surface Missile System (ASMA) was under consideration (b)(3) The nuclear warhead section was to be interchangeable with the HE warhead.[417]

Terminal Homing Vehicle

During the second quarter of 1969, it was also announced that the Air Force had started a program to evaluate the possibility of using the Minuteman in an offensive/defensive role. In the Terminal Homing Vehicle concept, the payload of the Minuteman would become a homing vehicle able to "home in on an incoming reentry vehicle." The vehicle would incorporate either a nonnuclear or nuclear kill warhead. The status reports from the Laboratory indicate that a joint LASL/SLA nuclear warhead data package had been prepared.[418]

LAR (Low-Angle Entry Vehicle)

In terms of the Low-Angle Entry Vehicle (LAR) it was reported in the W-Division third quarter report that an 18-month contract had been awarded for the conduct of the Feasibility Flight Test Program.[419] The July–September status report from the Laboratory notes, "...we do not expect to have discussions concerning the warhead until the end of the program; that is when the actual flight tests have been conducted."[420]

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[415] "Program Status Weapons Research and Development, July - September 1969 (U)," DIR-2187 (SRD) (no date), pp. 9–10.

[416] "W-Division Quarterly Status Report, October 1, 1969 through December 31, 1969," W-2235 (SRD) (January 15, 1970), p. 39, A86-016, 242-12.

[417] "Program Status Weapons Research and Development, April – June 1969, Part 2 of Two (U)," DIR-2180 (SRD) (no date), p. 11. "W-Division Quarterly Status Report, April 1, 1969 through June 30, 1969, Part 2 of Two," W-2199 (SRD) (July 15, 1969), p. 20, A86-016, 242-10.

[418] "Program Status Weapons Research and Development, April – June 1969, Part 2 of Two (U)," DIR-2180 (SRD) (no date), p. 11. "W-Division Quarterly Status Report, April 1, 1969 through June 30, 1969, Part 2 of Two," W-2199 (SRD) (July 15, 1969), p. 21, A86-016, 242-10.

[419] "W-Division Quarterly Status Report, July 1, 1969 through September 30, 1969," W-2217 (SRD) (October 15, 1969), p. 15, A86-016, 242-11.

[420] "Program Status Weapons Research and Development, July - September 1969 (U)," DIR-2187 (SRD) (no date), p. 10.

SAM-D (Surface-to-Air Missile-D)

The Army planned to replace the Nike Hercules and Hawk with a Surface-to-Air Missile-D (SAM-D).

(b)(3)

Air Interceptor Missile (AIM)

The final quarter 1969 report from W-Division notes that the Navy had submitted a request for an AEC Phase 2 feasibility study on possible warhead candidates for the Phoenix missile.[422] [Additional information on Phoenix is given in the 1970 section.]

(b)(3)

High-Yield Source

(b)(3)

ADAM (Advanced Atomic Demolition Munition)

During the first quarter of 1969, the Laboratory's Phase 2 input for the Advanced Atomic Demolition Munition (ADAM) study was coordinated within the Laboratory. This study was to be submitted early in April.[425]

(b)(3)

[422] "W-Division Quarterly Status Report, October 1, 1969 through December 31, 1969," W-2235 (SRD) (January 15, 1970), p. 38, A86-016, 242-12.

(b)(3)

[425] "Program Status Weapons Research and Development, January – March 1969, Part 2 of Two (U)," DIR-2172 (SRD) (no date), p. 10. "W-Division Quarterly Status Report, January 1, 1969 through March 31, 1969, Part 2 of Two," W-2193 (SRD) (April 15, 1969), p. 17, A86-016, 242-9.

The Laboratory quarterly report for July–September 1969 notes that the ADAM Phase 2 feasibility study had been published by the Army. The AEC Impact and Capabilities study had been published by the Albuquerque Operations Office (ALO).[426]

Advanced Sparrow

During the first quarter of 1969, there continued to be interest in what was called the Advanced Sparrow missile. The warhead was to weigh about 90 lb and have an 8-inch diameter and a length of 17.5 inches (b)(3) The warhead was to be a direct replacement of the conventional HE warhead.

(b)(3)

The first quarter report from W-Division notes that a joint LASL/SLA input had been submitted to AFWL for a Phase 1 feasibility study for a nuclear capability for the Advanced Sparrow missile.[428]

Walleye Phase 3

The Phase 3 for the Walleye missile warhead (BA72) was awarded in May 1969. It was noted that development would be mainly a Sandia activity.[429]

New Implosion System

(b)(3)

d. Projectiles and Earth-Penetrating Devices

Eight-Inch Artillery-Fired Atomic Projectile (AFAP)

During the first quarter of 1969, it was reported that the Phase 2 feasibility study and the additional Impact and Capability report for a new 8-inch nuclear artillery round was nearing completion (b)(3)

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[426] "Program Status Weapons Research and Development, July - September 1969 (U)," DIR-2187 (SRD) (no date), p. 48.

(b)(3)

[428] "W-Division Quarterly Status Report, January 1, 1969 through March 31, 1969, Part 2 of Two," W-2193 (SRD) (April 15, 1969), p. 17, A86-016, 242-9.

[429] "Program Status Weapons Research and Development, April – June 1969, Part 2 of Two (U)," DIR-2180 (SRD) (no date), p. 16.

(b)(3)

The Phase 2 study for the 8-inch AFAP was completed during the second quarter and the applicable reports were issued.[433]

155-mm

During the first quarter of 1969, the Phase 2 feasibility study for a new 155-mm nuclear round for the Army was reported to be nearing completion. The Los Alamos design group had proposed two designs.

(b)(3)

The April–June quarterly report announced that the Phase 2, 155-mm study had been completed; the Phase 2 meeting had been held in February 1969. The Phase 2 report was dated May 2, 1969; the Impact and Capabilities Study was dated April 18, 1969.[435]

(b)(3)

Engineering studies, gun-firing tests, and materials-development activities were in progress or planned.[438]

Bayonet

The first part of 1969 saw completion of the engineering tests for the Bayonet feasibility program.[439]

[433]"Program Status Weapons Research and Development, April – June 1969, Part 2 of Two (U)," DIR-2180 (SRD) (no date), p. 11. "W-Division Quarterly Status Report, April 1, 1969 through June 30, 1969, Part 2 of Two," W-2199 (SRD) (July 15, 1969), p. 19, A86-016, 242-10.

(b)(3)

[435]"Program Status Weapons Research and Development, April – June 1969, Part 2 of Two (U)," DIR-2180 (SRD) (no date), pp. 10–11. "W-Division Quarterly Status Report, April 1, 1969 through June 30, 1969, Part 2 of Two," W-2199 (SRD) (July 15, 1969), p. 19, A86-016, 242-10.

(b)(3)

[438]"Program Status Weapons Research and Development, October-December 1969 (U)," DIR-2195 (SRD) (no date), pp. 65–66.

[439]"Program Status Weapons Research and Development, January – March 1969, Part 2 of Two (U)," DIR-2172 (SRD) (no date), p. 12. "W-Division Quarterly Status Report, January 1, 1969 through March 31, 1969, Part 2 of Two," W-2193 (SRD) (April 15, 1969), p. 24, A86-016, 242-9.

e. Nonnuclear Kill

For the program involving the acceleration of steel as a kill mechanism, the Laboratory's 1969 first-quarter report states that the W59 warheads had been modified and were ready for delivery to the test facility.[440]

A meeting had been held to review and coordinate various phases of the hypervelocity-projectile tests on two modified W59 warheads in Mark-5 reentry vehicles. Two test shots were initially planned. One would use a 50-gram steel rod moving at 20,000 ft/s into the midsection of the W59. The other would use a 50-gram steel rod moving at 20,000 ft/s into the secondary of the W59.[441]

6. 1970

(b)(3)

CAFE (C-3 Alternate Front End)

In a TWX dated May 11, 1970, it was noted that there might be a ban on the use of MIRV (Multiple Independent Reentry Vehicle) type deployment. DOD personnel were therefore reviewing capabilities for alternate strategic missile loadings. In particular, the Navy was concerned about a design that could be used as a single RB on Poseidon.[442]

The W-Division third quarter (July 1, 1970, through September 30, 1970) report announced that a design study for CAFE had been prepared. The CAFE (C-3 Alternate Front End) study was to identify the preferred design for a new reentry body payload for the Poseidon C3 missile. It was reported that two possible modifications to the W67 warhead had been included in this study.

(b)(3)

The first CAFE Reentry Interchange Committee Meeting took place on July 15, 1970. An informal meeting was held between LASL/SLA and LMSC (Lockheed Missiles and Space Company) on July 22, 1970. In a submittal to C. E. Grant (through the Navy Plant Representative) at Lockheed Missiles and Space Company dated August 7, 1970, the Los Alamos and Sandia Albuquerque laboratories submitted a paper titled, "LASL/SLA Warhead Data for CAFE Study."

(b)(3)

Another meeting on the CAFE program took place on September 18, 1970. During this meeting, a follow-on phase of the CAFE study was requested

(b)(3)

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[440]"Program Status Weapons Research and Development, January – March 1969, Part 2 of Two (U)," DIR-2172 (SRD) (no date), p. 10.

[441]"W-Division Quarterly Status Report, January 1, 1969 through March 31, 1969, Part 2 of Two," W-2193 (SRD) (April 15, 1969), p. 18, A86-016, 242-9.

[442]USAEC, Thomas R. Clark, Wash., D.C. to AN1, USAEC, H. C. Donnelly, Albuq., N.M. et. al. (SRD) (May 11, 1970), 6 pp., A99-019-188-4.

(b)(3)

The fourth quarter report from W-Division for 1970 notes that the Poseidon C3 Alternate Front End Study had been completed by Lockheed Missiles and Space Company. The purpose of the study had been to identify the preferred design for a new reentry body payload, called the *Mk 1 Prime, for the Poseidon missile in the event that the Mk 3 MIRV system could not be* deployed as planned.

(b)(3)

The total warhead weight was 680 lb.[446]

Improved Spartan

(b)(3)

Phase 6 for the W71 would not be achieved until October 1974. (The weapon would be placed in the inactive stockpile in October 1976.[447])

In a February 24, 1970, letter to Chairman of the AEC, Glenn T. Seaborg, John S. Foster, Director of Defense Research and Engineering wrote, "The Department of Defense desires to determine the feasibility of a nuclear warhead for the Improved SPARTAN missile warhead section....The Improved SPARTAN missile is a sub-system of the SAFEGUARD ballistic missile defense system and is being designed to provide a long-range intercept capability in the exoatmosphere against ICBM and SLBM reentry vehicles (RVs), long-range intercept capability in the atmosphere against depressed trajectory RVs, a capability to intercept penetration-aided RVs, an endo- and exoatmospheric intercept capability against FOBS [Fractional Orbital Bombardment System], and an intercept capability against satellites (but only within missile performance limitations)." [Author's note: Wow, what an assignment!] Foster noted that the presently planned improved Spartan missile would use the Spartan missile's first and second stages while incorporating a new third stage(

(b)(3)

An effort through Phase 2 was requested for this improved Spartan missile.[448]

(b)(3)

The Laboratory's quarterly report for January–March 1970 states, "Though there are many system parameters as yet unresolved, the AEC has received a formal request to participate in the Phase 2 Feasibility study of warhead designs for the Modified Spartan missile system."

(b)(3)

[446]"Program Status Weapons Research and Development, October-December 1970 (U)," Los Alamos Scientific Laboratory report LA-4614-MS (SRD) (February 1971), p. 42. "W-Division Quarterly Status Report, October 1, 1970 through December 31, 1970," W-2301 (SRD) (January 15, 1971), p. 66, A86-016, 242-15.

[447]"FY 1994 Annual Weapons Program Report," DOE Operation Office report (SRD) (October 1, 1994), pp. 318–322.

[448]John S. Foster, Jr. to Honorable Glenn T. Seaborg (SRD) (February 24, 1970), 5 pp., A99-019, 186-10.

(b)(3)

The document noted that the improved Spartan would incorporate a larger and more powerful third stage motor. This new motor would allow for greater missile maneuverability and therefore allow a reduction in warhead miss distance. It would also allow for a "loiter" capability. The warhead would need to be multipurpose.

(b)(3)

It was also noted that if the Safeguard system were extended to maximum deployment, it could be extended to include an area defense of the population against a light or

(b)(3)

irrational attack, or against accidental launches.

(b)(3)

Mk 19

(b)(3)

A TWX dated September 15, 1970, pointed out that the system cost for the Minuteman III and MIRV was 2.2 billion. The projected cost for the Mk 19 was approximately 130 million. Thus. the R&D cost for the Mk 19 was 5% of the total system costs.[467]

(b)(3)

FUFO

During 1970, the DOD guidance placed emphasis upon a new FUFO bomb

(b)(3)

SABMIS

There also continued to be an interest in a Sea-Based Anti-Ballistic Missile Intercept System. It was reported that development schedules for this system were such that tests of the warheads themselves would not be scheduled for FY 1971.

(b)(3)

[467]D. W. Bergen, Los Alamos Scientific Laboratory, Los Alamos, N.M. to C. I. Hudson, University of California, Lawrence Radiation Laboratory (SRD) (September 15, 1970), p. 3, A99-019, 188-4.

(b)(3)

(b)(3)

High-Yield Bomb (HYB), Formerly FUFO

In a February 28, 1972, memo, D. P. MacDougall reported that Giller in a January 20, 1972, document had indicated that he anticipated that a Phase 3 request might be initiated in the FY 1972–1974 time period for a High-Yield Bomb (HYB) (formerly FUFO).[543]

The second quarter report from the Laboratory for 1972 includes, as part of the High-Yield Bomb program, what was to become a very important project for the Laboratory. The report states, "The explosive TATB (1,3,5-triamino-2,4,6-trinitrobenzene) was first described in 1888, but was recognized as a very interesting heat-resistant explosive only in the 1950s. At that time the Naval Ordnance Laboratory reported briefly on its properties and presented a reasonable synthesis." The report notes that this material had a great insensitivity to impact and friction and an explosive power superior to that of other heat-resistant explosives,

(b)(3)

The third quarter report for 1972 states, "We have continued experiments to characterize the 90/10 TATB-Kel-F 800 material discussed last quarter, hampered somewhat by our limited stock of material. First deliveries of TATB from Pantex are expected soon to alleviate this shortage."[545]

The third quarter report also states, "The USAF and USN have studied the 'Final Report of the Phase 2 Feasibility Study of the High Yield Bomb,' dated March 21, 1972, ...and agree that it is technically feasible to develop a high-yield bomb that meets the stated requirements, with a minimum 4-yr development time, and that no bombs that meet the requirements of the HYB are currently available or in production. Subsequently, the Services have requested a Phase 3 Development Engineering program for the HYB.

(b)(3)

[543]D. P. MacDougall to Distribution, Subject: "Program Planning," ADW-204 (SRD) (February 28, 1972), 3 pp., B11. Drawer 49. Folder 1 of 5.

(b)(3)

[545]Leslie M. Redman and Cecil C. Carnes, Jr., "Quarterly Status Report on Weapons Research and Development for the Period Ending September 30, 1972 (U)," Los Alamos Scientific Laboratory report LA-5130-PR (SRD) (January 1973), pp. 53–54.

(b)(3)

The second quarter report from the Laboratory for 1973 noted that the Mk 400 was the reentry body for the C4 Trident missile; it was being designed for use on the new Trident submarine

(b)(3)

! (Phase 3 development of the W76 WH for the Mk 4 RB was awarded to LASL and SLA on April 27, 1973.)"[264]

11. Significance

It had been a long and at times bitter fight. But the laboratory at Los Alamos had won the long desired strategic warhead assignment. However, the laboratory staff was now under extreme pressure to develop and design a warhead that would (1) meet the yield requirement, (2) meet the size and weight requirements, (3) achieve the vulnerability and safety requirements, and (4) at the same time satisfy the minimum number of NTS development tests, the strict time restraints, as well as the budget limits that had been placed on weapon development.

It was never envisioned that the in the year 2003 planning would be in progress to retain the W76 in the U.S. stockpile.

C. Harold Agnew

1. Proponent

While the entire staff at Los Alamos worked hard to obtain the Phase 3 for the Mk 400, one of the chief proponents for this award was Harold Agnew. (From the information given in Chapter I, the reader will recall that Agnew became Laboratory Director in 1970.) Agnew felt that there were many reasons why the award should go to Los Alamos

(b)(3)

[264]Leslie M. Redman, "LASL Weapons Quarterly (U), for the Period Ending June 30, 1973," Los Alamos Scientific Laboratory report LA-5401-PR (SRD) (September 1973), p. 58.

Agnew voiced his viewpoint in numerous letters and TWXs to Washington. Considering the fact that he was on many panels and committees that included military personnel, Agnew must have also presented his viewpoint informally at appropriate moments.

The Agnew concerns will be discussed in greater detail in the following sections.

2. Reliability

The folklore among the "old timers" at Los Alamos is that it was Agnew that pressed for the testing of Livermore's mechanical safing systems employed in some of their weapons. The objective of these tests was to determine if the safing system could actually be withdrawn in order to prepare the warhead for activation. The reader of this author's previous document, LA-13755-H (SRD), will recall that when these tests were undertaken not all the safing systems worked as required. The question then became "How many duds in the system?" Agnew apparently noted this problem at opportune moments. For example in a November 29, 1966, letter to General Earle G. Wheeler, Chairman, Joint Chiefs of Staff, Agnew wrote, "I have been worrying for several years about the actual implementation of what we commonly refer to as our assured destruction capability. Recently a great deal of effort has been directed toward reducing the vulnerability of the forces we have for this role against possible enemy action throughout all stages of their stockpile-to-target sequence. However, I wonder if we have protected ourselves to the degree we might have against basic system component design failures which to some degree or another always turn up. The most recent example is the MK-47 Polaris problem." In discussing the prospect for the Mk 3 and Mk 18 carrying the same warhead, Agnew wrote, "If a defect turned up in the warhead some years from now the complete force could be in trouble." He went on to say, "If I were in a position to make such decisions I would suggest that in a missile system such as Poseidon or the new Minuteman that there be a mix of basic missiles, perhaps a different mod for every one or two hundred missiles and a mix of RV's with warheads. I would have a warhead mix such that no more than a quarter of the missile warheads were identical assuming a total build of over a thousand. The different RV's could also pose additional problems for any enemy ABM system."[265]

Delmar Crowson, Director of Military Application, agreed with Agnew. A few months after the Agnew letter, in a memo dated February 9, 1967, for the Chairman, Military Liaison Committee, Crowson wrote, "I believe that Dr. Agnew's suggestion has considerable merit. ...Three examples in the strategic missile warhead stockpile serve as cases in point: the recent ANA (Actuator, Nuclear Arming) failure in the MK 47Y2 warhead for POLARIS; the high-altitude failure of the arm-safe inspection port in the MK 58 warhead (MK 2 R/V) for POLARIS; and the ANA failure in the MK 56 warhead for MINUTEMAN. In each case it has been comforting to have alternate warheads in the stockpile..."[266] [Author's note: The three warheads cited by Crowson were all designed at Livermore.]

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[265]H. M. Agnew to General Earle G. Wheeler, USA, W-1989 (SRD) (November 29, 1966), p. 1, B11, Drawer 56, Folder 1 of 4.

[266]Delmar L. Crowson, Memorandum for Chairman, Military Liaison Committee to the U. S. Atomic Energy Commission, Subject: "Concept of Mixed Warheads for Strategic Missiles," (SRD) (February 9, 1967), 2 pp., B11, Drawer 56, Folder 1 of 4.

4. Engineering Philosophy

Another argument, related somewhat to the "don't put all your eggs in one basket" argument, was the point that Agnew made about the differences in engineering philosophy between the two laboratories.

In a letter to Camm dated September 11, 1972, Agnew wrote, "One strength of this Laboratory has been its consistent ability to meet the actual needs of the military with realistic design concepts and practical engineering. In addition, we are very conscious of development and production costs and involve our weapon engineering people in the design from the start. This has been an important aspect of our ability to minimize costs and stay within budgets while at the same time delivering reliable hardware. We feel that our past experience with Mk 18 and ABC, together with our current Mk 400 efforts, will enable us to continue this for the Mk 400 warhead."[273]

In his letter to Camm on November 27, 1972, Agnew reported, "As we have made clear, there are differences in basic physics design philosophies and engineering approaches between the two laboratories." He indicated, "In particular, LASL design philosophy is to rely more on demonstrated fabrication techniques (often worked out and demonstrated at LASL), and simplicity in design wherever possible. We feel that our approach has led to significant differences between our warhead design and those of LLL. A mixture of LLL and LASL warheads definitely should improve the confidence in the strategic missile deterrent." Agnew also noted "The AEC has always supported the two laboratories to make certain that, through competition, different options would be available to them and to the DoD. Not to take advantage of these options is to ignore the basic rationale for supporting the opportunity to provide the options in the first place. In today's climate this point should receive very serious weighting in your deliberation."[274]

5. Cooperation

Agnew tried to make it clear that the LASL group was willing to cooperate to the fullest extent and to provide whatever the Military wanted.

On September 11, 1972, Agnew wrote Major General Camm, "It is important also to realize that we have worked actively with Lockheed and SSPO for the past two years on the Mk 400 and before that on the CAFE program and have a good working relationship with both... Stan Burriss, President of Lockheed, is very friendly to the LASL having been a senior member of LASL before joining Lockheed."[275]

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[273]H. M. Agnew to Major General Frank A. Camm, DIR-2293 (SRD) (September 11, 1972), 3 pp., B11, Drawer 56, Folder 1 of 4.
[274]H. M. Agnew to Major General F. A. Camm, DIR-2296 (SRD) (November 27, 1972), 7 pp., B11, Drawer 56, Folder 1 of 4.
[275]H. M. Agnew to Major General Frank A. Camm, DIR-2293 (SRD) (September 11, 1972), 3 pp., B11, Drawer 56, Folder 1 of 4.

In his November 27, 1972, letter to Camm, Agnew implied that all the LASL team was eager to work with the Navy and the Navy's contractors and vice versa. Agnew stated, "In a nutshell, the Navy, Lockheed and the Air Force wish to work with us." Agnew also noted, "Industry and the DoD sense that they are missing an important design input and working relationship by not interacting directly with the LASL in the strategic offensive warhead area."[276]

6. Program Balance

Agnew felt that to remain a viable laboratory, each laboratory must work on all the different types of weapons going to the stockpile.

In a letter dated November 17, 1970, to Michael May at Livermore, Agnew stated, "...I believe it would not be a healthy condition for the country, the AEC, or the laboratories if the LASL were to concentrate on providing only tactical offensive warheads and bombs to the stockpile and LRL were to limit its endeavor to strategic offensive warheads." Agnew informed May, "...we are concentrating a sizeable portion of our advanced development technology on getting into a position to respond rapidly to the need for a new strategic offensive warhead whenever the AEC is called upon to provide one.

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In a letter dated August 10, 1972, Agnew noted that during the late 1950s time period it had been agreed that both the Los Alamos and Livermore laboratories should maintain competence in all areas of weapon design; each laboratory would not just specialize in one area of nuclear weapon technology. He stated, "At the same time, it was agreed by both laboratories and by DMA that both laboratories would maintain competence 'across the board' rather than have one laboratory specialize in other areas of nuclear weapon technology."[278]

In his November 27, 1972, letter Agnew noted, "To achieve proper balance, a design laboratory must receive design responsibility for weapons program (i.e., Phase 3 assignments) in all areas of nuclear weapons within a reasonable time period. Otherwise, capabilities can atrophy or disappear because of the feeling that 'We never get those jobs.' When this happens the advantages of two-laboratory competition in the nuclear weapon field will disappear."[279]

Agnew also reported that he expected the W74 effort to decline at the same time that the Mk 400 effort was projected to increase. Agnew noted, "Consequently we anticipate no staffing problems for the Mk 400 Program. We need the work."[280]

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[276]H. M. Agnew to Major General F. A. Camm, DIR-2296 (SRD) (November 27, 1972), 7 pp., B11, Drawer 56. Folder 1 of 4.

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[278]H. M. Agnew to Major General Frank A. Camm, DIR-2292 (SRD) (August 10, 1972), 7 pp., B11, Drawer 56, Folder 1 of 4.

[279]H. M. Agnew to Major General F. A. Camm, DIR-2296 (SRD) (November 27, 1972), 7 pp., B11, Drawer 56, Folder 1 of 4.

[280]H. M. Agnew to Major General F. A. Camm, DIR-2296 (SRD) (November 27, 1972), 7 pp., B11, Drawer 56, Folder 1 of 4.

7. Yield: The Confetti Argument

Agnew felt that the yield of the W68 was too low to be really effective. In addition, in terms of the overall total yield available from all the W68 warheads, the W68 design was very costly in terms of the amount of required special nuclear materials.

In an April 1972 TWX to Assistant Director for Safety and Liaison (Division of Military Application) Colonel Robert T. Duff, Agnew reported that he was worried about maintaining the U.S. nuclear deterrent. Agnew noted, "It occurs to me that as we go to lower and lower yields in our strategic missile warheads and the Soviet Union builds up a better and better civil defense position, the reality of this deterrent may become questionable.

(b)(3)

If the Soviet leadership believes this, then our strategic deterrent will have lost a good deal of its force. If our MIRV trend continues we'll be threatening to throw confetti at a potential aggressor. Confetti has high penetration and survivability but little deterrent power."[281]

In a letter dated October 10, 1972, to Giller, at that time Assistant General Manager for National Security, Agnew again noted several reasons why low yield warheads might not be the best solution for maximizing the deterrence capability of the stockpile. He reported that considering the number of required submarines and the low efficiency in their use of special nuclear material, the low-yield warheads were not very cost effective. Moreover, Agnew pointed out that for the Hiroshima device, the effects on Hiroshima in terms of loss of substantial buildings and the people in them "wasn't all that impressive." In terms of loss of life, the USSR had lost more than ten million people in WWII. Although the Soviets had an extensive civil-defense network in place, even if that did not work to reduce loss of civilian lives, the Soviets might not mind losing a few people. Agnew wrote, "Again, to me, to continue to increase warhead numbers at the cost of a decrease in yield per warhead could eventually lead to no deterrence in the minds of those we hope to deter." Agnew stated, "I feel very strongly that we should endeavor to convince the DoD that what they should have on the next round is a mix of yields.

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8. Capability

Agnew in his August 10, 1972, letter to Camm pointed out that the Los Alamos group had been developing suitable technology applicable to the new strategic missile warheads. He wrote, "In summary then, we have been working very hard to provide the very latest technology in warhead designs incorporating the most advanced minimum weight hardening techniques to provide an optimum warhead for the next round of strategic missile warheads. In fact, our work has been of such outstanding quality that we have been invited by Admiral Levering Smith to

[281]H. M. Agnew, University of California, Los Alamos Scientific Laboratory, Los Alamos, N.M. to BY3/Colonel Robert T. Duff, USAF, Assistant Director for Safety and Liaison, Division of Military Application USAEC, Wash., D.C. (SRD) (April 14, 1972), pp. 1–2, B11, Drawer 56, Folder 1 of 4.

(b)(3)

join his Steering Task Group for the FBM Weapon System Program in anticipation of our supplying TRIDENT with its warhead."[283]

Agnew felt that the LASL group had had extensive experience in the areas of vulnerability, hardening, and RV/warhead integration. Again, in a letter to Camm dated September 11, 1972, Agnew wrote, "Also, our in-house work and underground testing program in the vulnerability and hardening area have made a significant contribution to the nation's overall capability in this area." He also noted, "One unique advantage we have is that while we have a solid background of experience in reentry system design we are not tied to our past achievements and thereby inhibited in our approach to new designs."[284] In his November 27, 1972, letter to Camm, Agnew gave examples of how the LASL team had been the leader in several aspects of the vulnerability program.

(b)(3)

This experience had been demonstrated in the successful Mk 18 and Mk 400 programs. With money very tight and the need to limit the expense of testing at NTS, the LASL team was in the best position to develop the Mk 400 warhead with a minimum number of tests. Agnew told Camm, "Once the Phase 3 has been awarded, we will design a package in which both the primary and secondary are so configured as to provide the best possible warhead to satisfy the specific DoD requirements."[286]

9. Promise of the Next Strategic Missile Warhead

In his August 10, 1972, letter to Camm in which Agnew discussed the history of previous weapon assignments, Agnew noted that at the time of the Mk 3/W68 warhead assignment to Livermore the Los Alamos group had been promised the development responsibility "for the next strategic missile warhead, whatever it might be..."[287]

In a letter dated September 11, 1972, to Camm, Agnew again reminded Camm that LASL had been told that they would receive development responsibility for the next strategic reentry system. To meet this obligation, the members of the LASL weapon groups had been developing and testing warheads for the Mk 19, Mk 18, ABC, and Mk 400 programs. This work had resulted in the Laboratory being very involved in these types of systems. (b)(3) Agnew reported, "These two tests cover the spectrum of possible secondary designs for the Mk 400." Agnew also noted that the design of a suitable primary for the Mk 400 program was underway. He concluded his September 11 letter by stating "We feel

[283]H. M. Agnew to Major General Frank A. Camm, DIR-2292 (SRD) (August 10, 1972), 7 pp., B11, Drawer 56, Folder 1 of 4

[284]H. M. Agnew to Major General Frank A. Camm, DIR-2293 (SRD) (September 11, 1972), 3 pp., B11, Drawer 56, Folder 1 of 4.

(b)(3)

[286]H. M. Agnew to Major General F. A. Camm, DIR-2296 (SRD) (November 27, 1972), 7 pp., B11, Drawer 56, Folder 1 of 4.

[287]H. M. Agnew to Major General Frank A. Camm, DIR-2292 (SRD) (August 10, 1972), p. 4, B11, Drawer 56, Folder 1 of 4.

that our past experience with Mk 18 and ABC, together with our current Mk 400 efforts, will enable us to continue this [successful effort] for the Mk 400 warhead."[288]

10. Morale

Agnew was fearful concerning the effect that an award of the Phase 3, Mk 400 warhead to Livermore might have on Los Alamos weapon personnel. Agnew in his November 27, 1972, letter to Camm noted, "After having had the vision to work in this field and having been extremely successful, not to receive this assignment would have a very severe impact on our staff morale."[289]

[288]H. M. Agnew to Major General Frank A. Camm, DIR-2293 (SRD) (September 11, 1972), 3 pp., B11, Drawer 56, Folder 1 of 4.
[289]H. M. Agnew to Major General F. A. Camm, DIR-2296 (SRD) (November 27, 1972), p. 7, B11, Drawer 56, Folder 1 of 4.

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